FAA-E-2937
September 21, 1999

UNITED STATES DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

SPECIFICATION

PERFORMANCE TYPE ONE
LOCAL AREA AUGMENTATION SYSTEM
GROUND FACILITY

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1. Scope

1.1 Identification

This specification establishes the performance requirements for the Federal Aviation Administration (FAA) Performance Type (PT) 1 Local Area Augmentation System (LAAS) Ground Facility (LGF). Requirements contained within this specification are the basis to augment the Global Positioning System (GPS) to provide precision approach capability down to Category I minimums. The performance requirements are consistent with those requirements defined in the Requirements Document for the GPS Local Area Augmentation System (GPS/LAAS) (FAA, 1997), the Minimum Aviation System Performance Standards (MASPS) for the LAAS (RTCA/DO-245, 1998), and the Minimum Operational Performance Standards (MOPS) for the LAAS (RTCA, draft version 14). Some functional requirements are embedded in the LGF performance requirements.

1.2 System Overview

The LGF is a safety-critical system consisting of the hardware and software that augments the GPS Standard Positioning Service (SPS) to provide for precision approach and landing capability in the United States National Airspace System (NAS). The positioning service provided by GPS is insufficient to meet the integrity, continuity, accuracy, and availability demands of precision approach and landing navigation. The LGF, using differential GPS concepts, augments the GPS SPS in order to meet these requirements.

The GPS/LAAS, as an integrated system, is maintained as three separate segments (illustrated in Figure 1-1): a) the LGF; b) the Space Segment; and c) the Airborne Subsystem. The LGF provides differential corrections, integrity parameters, and precision approach pathpoint data that are broadcast via a Very High Frequency (VHF) Data Broadcast (VDB) to the Airborne Subsystem for processing. The Space Segment provides the LGF and Airborne Subsystem with GPS and Satellite-Based Augmentation System (SBAS) ranging signals and orbital parameters. The Airborne Subsystem applies the LGF corrections to the GPS and SBAS ranging signals to obtain position with the required accuracy, integrity, continuity, and availability. The differentially corrected position is used, along with pathpoint data, to supply deviation signals to drive appropriate aircraft systems supporting precision approach.

The LGF provides FAA Airway Facilities and Air Traffic with detailed status information and a maintenance and control capability. Status and control capabilities are executed through either a Maintenance Data Terminal (MDT) or a Remote Maintenance Interface (RMI). The MDT display is provided as part of the LGF, while the RMI will allow for future integration with a remote maintenance monitoring capability. Additionally, the LGF sends status information to FAA Air Traffic Control (ATC) via an Air Traffic Control Unit (ATCU). The ATCU provides air traffic controllers with LGF status information and runway control capabilities. For maintenance purposes, LGF status information is available via the Local Status Panel (LSP) and the Remote Status Panel (RSP).

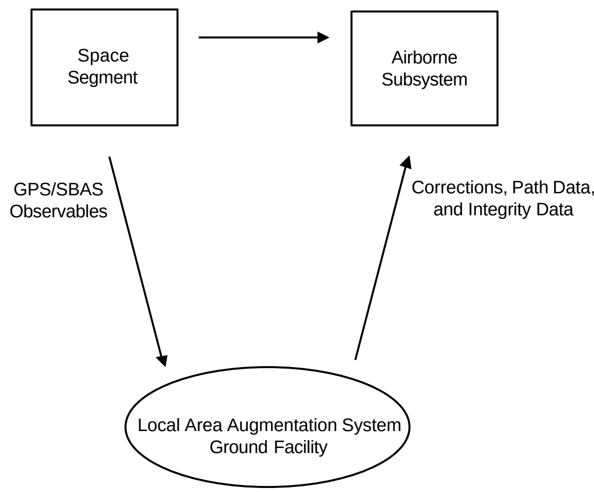


Figure 1-1. Local Area Augmentation System

1.3 Document Overview

The format of this document complies with FAA-STD-005E, MIL-STD-961D, and MIL-STD-962C. Section 1 provides a general overview of the LGF and a high-level introduction to the requirements for implementing operational satellite-based precision approach. Section 2 lists the documents from which requirements are referenced or derived. Section 3 contains the performance, functional, operational, and maintenance requirements for the LGF. Section 4 contains verification requirements for both hardware and software. Appendix A contains details of the Interference Environment. Appendix B provides Configuration Management and Quality Control conditions. Appendix C is the Verification Requirements Traceability Matrix. Appendix D supplies a listing and expansion of acronyms. Appendix E provides information on the Assumed Airborne Processing. Appendix F supplies information on the operational environment to aid in proper integration with existing facilities and procedures. Appendix G provides the Integrity Risk and Continuity Risk Allocation trees. Exceptions to RTCA/DO-246 are contained in Appendix H. The definitions for the Final Approach Segment are located in Appendix I. Appendix J provides a listing of documents normally required for a government-procured the LGF.

2. Applicable Documents

The following documents form a part of this specification and are applicable to the extent specified herein. In case of conflict between referenced documents and the contents of this specification, the contents of this specification shall take precedence.

2.1 Government Documents

2.1.1 Specifications

2.1.1.1 Federal Aviation Administration

Federal Aviation Administration. (1993). *Electronic equipment, general requirements* (FAA-G-2100F). Washington, DC: U.S. Government Printing Office.

Federal Aviation Administration. (1996). *Electrical work, interior* (FAA-C-1217F). Washington, DC: U.S. Government Printing Office.

Federal Aviation Administration. (1975). *Technical instruction book manuscripts: electronic equipment requirements for part - preparation of manuscript* (FAA-D-2494B). Washington, DC: U.S. Government Printing Office.

Federal Aviation Administration. (1997). *Wide area augmentation system (WAAS) specification* (FAA-E-2892B). Washington, DC: U.S. Government Printing Office.

2.1.1.2 Department of Transportation

Department of Transportation. (1995). *GPS standard positioning service (SPS) signal specification*.

2.1.2 Standards

2.1.2.1 Federal Aviation Administration

Federal Aviation Administration. (1991). *Standard engineering drawing preparation and support* (FAA-STD-002). Washington, DC: U.S. Government Printing Office.

Federal Aviation Administration. (1996). *Design standards for national airspace system physical facilities* (FAA-STD-032D). Washington, DC: U.S. Government Printing Office.

Federal Aviation Administration. (1962). *Paint systems for structures* (FAA-STD-003). Washington, DC: U.S. Government Printing Office.

Federal Aviation Administration. (1994). *Quality control program requirements* (FAA-STD-013D). Washington, DC: U.S. Government Printing Office.

Federal Aviation Administration. (1996). *Standard practice preparation of specifications, standards and handbooks* (FAA-STD-005e). Washington, DC: U.S. Government Printing Office.

Federal Aviation Administration. (1992). *Transient protection, grounding, bonding and shielding requirements for electronic equipment* (FAA-STD-020B). Washington, DC: U.S. Government Printing Office.

2.1.2.2 Military

Department of Defense. (1997). *Configuration management guidance* (MIL-HDBK-61). Washington, DC: U.S. Government Printing Office.

Department of Defense. (1995). *Department of defense standard practice for defense specifications* (MIL-STD-961D). Washington, DC: U.S. Government Printing Office.

Department of Defense. (1995). *Department of defense standard practice defense standards and handbooks* (MIL-STD-962C). Washington, DC: U.S. Government Printing Office.

2.1.3 Federal Aviation Administration Orders

Federal Aviation Administration. (1998). *Electrical power policy implementation at national airspace system facilities* (FAA Order 6950.2D). Washington, DC: U.S. Government Printing Office.

Federal Aviation Administration. (1999). *Federal aviation administration information systems security program* (FAA Order 1370.82 Draft Version, dated 7/29/99). Washington, DC: U.S. Government Printing Office.

Federal Aviation Administration. (1991). *General maintenance handbook for airway facilities* (FAA Order 6000.15B). Washington, DC: U.S. Government Printing Office.

Federal Aviation Administration. (1991). *NAS configuration management* (FAA Order 1800.8F). Washington, DC: U.S. Government Printing Office.

Federal Aviation Administration. (1983). *Radiation health hazards and protection* (FAA Order 3910.3A). Washington, DC: U.S. Government Printing Office.

2.1.3.1 Other Government Documents

National Institute of Science and Technology. (1999). *CS2 protection profile for near-term COTS*. Washington, DC: U.S. Government Printing Office.

Federal Aviation Administration. (1999). *LAAS concept of operations* (draft version 4.7). Washington, DC: U.S. Government Printing Office.

Federal Aviation Administration. (1985). *Obstruction marking and lighting* (FAA AC 70/7460-1J). Washington, DC: U.S. Government Printing Office

Federal Aviation Administration. (1997). *Requirements document for the GPS local area augmentation system (GPS/LAAS)*. Washington, DC: U.S. Government Printing Office.

Federal Aviation Administration. (1986). *Specification for obstruction lighting equipment* (AC 150/5345-43E). Washington, DC: U.S. Government Printing Office.

2.2 Non-Government Documents

International Civil Aviation Organization. (1999). *Ground based augmentation system standards and recommended practices*. Proceedings of the Global Navigation Satellite System Panel (GNSSP) Third Meeting, Montreal, Canada 12 to 23 April 1999, Report on Agenda Item 1.

RTCA, Incorporated. (1998). *GNSS based precision approach local area augmentation system (LAAS) signal-in-space interface control document* (RTCA/DO-246). Washington, DC: RTCA, Incorporated.

Electronic Industries Association. (1991). *Interface between data terminal equipment and data circuit-terminating equipment employing serial binary data interchange* (EIA/TIA-232-E).

Electronic Industries Association. *National consensus standard for configuration management* (EIA-649).

National Fire Protection Association. (1996). *NFPA 70, national electrical code* (1996 ed.). Quincy, MA: National Fire Protection Association.

RTCA, Incorporated. (1999). *Minimum operational performance standards for global positioning system/local area augmentation system airborne equipment* (RTCA/DO-XXX draft 14). Washington, DC: RTCA, Incorporated.

RTCA, Incorporated. (1998). *Minimum operational performance standards for global positioning system/wide area augmentation system airborne equipment* (RTCA/DO-229A). Washington, DC: RTCA, Incorporated.

RTCA, Incorporated. (1998). *Minimum aviation system performance standard for the local area augmentation system (LAAS)* (RTCA/DO-245). Washington, DC: RTCA, Incorporated.

RTCA, Incorporated. (1993). *Software considerations in airborne systems and equipment certification* (RTCA/DO-178B). Washington, DC: RTCA, Incorporated.

3. Requirements

This section prescribes functional and performance requirements. Functional requirements, and their groupings, do not imply allocation of functionality to hardware and software design. No design or algorithms are specified, except where required to establish interoperability.

3.1 Local Area Augmentation System Ground Facility General Requirements

3.1.1 Coverage Volume

The LGF approach coverage volume is defined to be the volume of airspace where the LGF meets the signal strength, accuracy, integrity, continuity, and availability requirements of this specification. The LGF will provide the level of service necessary to support Category 1 operations to all runways at a given airport. The VDB is required to broadcast an omnidirectional signal to accommodate terminal and surface navigation, surveillance, and other users requiring Position, Velocity, and Time (PVT) information, but may be limited by the existence of terrain or obstacles on or around the airport.

3.1.1.1 Approach Coverage Volume

When the installed on-channel assigned power is set to the lower monitor limit, the LGF shall meet the minimum field strength requirements of Section 3.2.2.4 for each Category 1 approach (depicted in Figure 3-1). The approach and missed approached coverage volume shall be:

a. Approach:

    1. Laterally beginning at 450 ft each side of the Landing Threshold Point (LTP) or Fictitious Threshold Point (FTP) and projecting out ± 35° either side of the final approach path to a distance of 20 nm from the LTP/FTP.

    2. Vertically, within the lateral region, between 10,000 ft Above Ground Level (AGL) and the plane inclined at 0.9° originating at the LTP/FTP and down to 50 ft above the runway.

b. Missed Approach:

    1. Laterally ± 1.0 nm either side of the runway centerline from the approach end of the runway to 4.0 nm beyond the departure end of the runway.

    2. Vertically, within the lateral region, between 10,000 ft AGL and the plane inclined at 0.9° above the horizontal plane and passing 50 ft above the LTP/FTP level along a horizontal plane to the Flight Path Alignment Point (FPAP), then continuing along a horizontal plane inclined at 0.9°.

Note: Missed approach coverage may be affected by the siting of the VDB antenna.

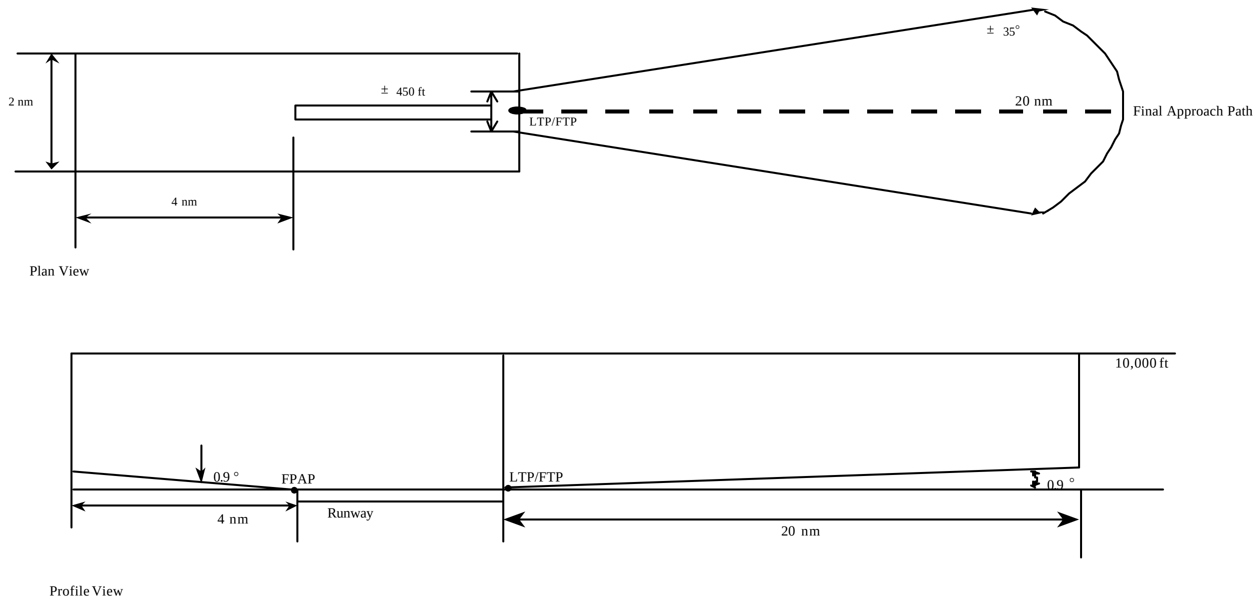


Figure 3-1. Approach Coverage Requirements

3.1.1.2 Very High Frequency Data Broadcast Coverage Volume

3.1.1.2.1 Lower Alarm Limit

The LGF shall meet the minimum field strength requirements of Section 3.2.2.4 when there is no blockage of line of sight due to local terrain or obstacles, given a flat ground plane with a reflectivity of 0.9, when the on-channel power is set to the lower alarm limit, and within the following coverage volume:

a. Laterally:

1. encompassing 360° around the VDB antenna,
2. beginning at 200 m from the VDB antenna, and
3. extending to 23 nm,

b. Vertically, within the lateral region:

1. within 3 nm of the VDB antenna, between the horizontal plane 12 ft above the ground at the antenna and a conical surface inclined at 85° above the horizontal plane, up to a height of 10,000 ft and
2. from 3 nm to 23 nm, between 10,000 ft AGL and a conical surface that is inclined at 0.9° above the horizontal plane with an origin 274 ft below the ground at the antenna.

3.1.1.2.2 Nominal Power

The LGF shall not exceed the maximum field strength requirements of Section 3.2.2.4 when there is no blockage of line of sight due to local terrain or obstacles, given a flat ground plane with a reflectivity of 0.9, when the on-channel power is set to the nominal, and within the coverage volume specified in Section 3.1.1.2.1.

Figure 3-2 depicts a representation of the VDB coverage volume.

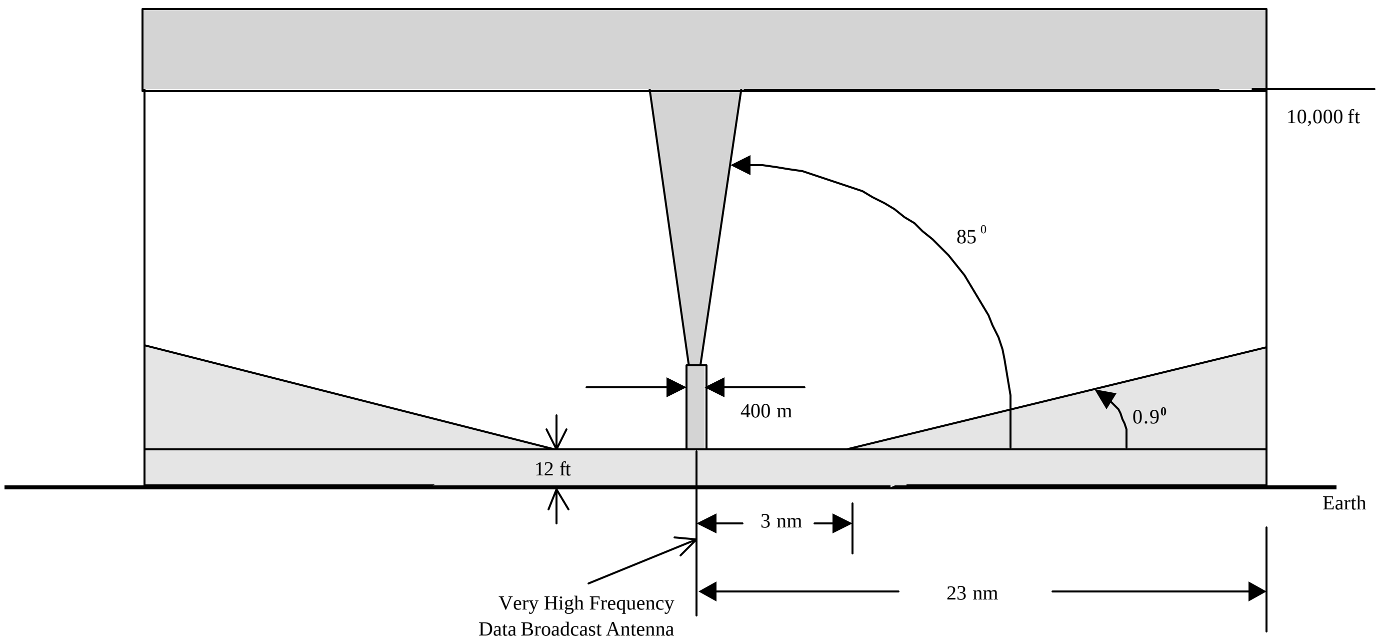


Figure 3-2. Local Area Augmentation System Ground Facility Coverage Volume

3.1.2 Integrity

3.1.2.1 Integrity of Ranging Sources

The probability that the LGF transmits Misleading Information (MI) for 3 seconds or longer due to a ranging source failure shall not exceed 1.4×10^{-7} during any 150-second approach interval. This requirement has been allocated as shown in the Integrity Risk Allocation Tree (Appendix G) and to the requirements in

a. Section 3.2.1.2.7.3.1,

b. Section 3.2.1.2.7.3.2,

c. Section 3.2.1.2.7.3.3, and

d. Section 3.2.1.2.7.3.4.

3.1.2.2 Integrity of the Ground Facility

The probability that the LGF broadcasts erroneous data, or that one or more failures exist that affect the smoothed pseudorange corrections (pr_sca) from more than one Reference Receiver (RR) for 3 seconds or longer shall not exceed 1×10^{-8} in any 150-second interval. Erroneous data are defined as data that do not meet the requirements in the following sections:

a. Section 3.2.1.2.1,

b. Section 3.2.1.2.7.1,

c. Section 3.2.1.2.7.5,

d. Section 3.2.1.2.7.6 (parent paragraph only),

e. Section 3.2.1.2.7.7 (parent paragraph only),

f. Section 3.2.1.2.7.8,

g. Section 3.2.1.3.5,

h. Section 3.2.1.3.6,

i. Section 3.2.1.3.7,

j. Section 3.2.1.3.8,

k. Section 3.2.1.3.9,

l. Section 3.2.1.3.10, and

m. Section 3.2.1.4.

Note: Failure to satisfy the overbounding requirement of Section 3.2.1.2.7.7 due to an LGF failure or change in local environment (i.e., multipath) as described in Section 3.2.1.2.7.7.1 is included in the 10^{-8} per approach allocation. The performance of the LGF monitor, together with the underlying probability that such a condition exists, is included in the 10^{-8} per approach. Risk that s_{pr_lgf} does not meet the requirement in Section 3.2.1.2.7.7 under fault-free conditions (both system and local environment), and risk that $s_{spatial\_dec}$ bounds spatial decorrelation errors, are not included in the 10^{-8} per approach. These risks will be managed as part of the LGF qualification.

3.1.2.3 Integrity of a Single Reference Receiver

The probability that an undetected failure exists that affects any smoothed pseudorange, any predicted range, or any smoothed pseudorange correction from a single RR shall not exceed $1\text{x}10^{-5}$ in any 150-second interval.

3.1.2.4 Latent Failures

Compliance with requirements in Sections 3.1.2.1, 3.1.2.2, and 3.1.2.3 shall account for the probability that the associated monitors have failed.

3.1.3 Continuity

3.1.3.1 Very High Frequency Data Broadcasting Transmission Continuity

The probability of an unscheduled interruption of the VDB transmission, where messages are not transmitted in accordance with Section 3.2.2 for a period equal to or greater than 3 seconds, shall not exceed $1x10^{-6}$ in any 15-second interval. On average, the LGF shall transmit at least 999 correctly formatted messages out of 1000 consecutive messages.

3.1.3.2 Reference Receiver and Ground Integrity Monitoring Continuity

The probability that the number of valid B-values is reduced for any valid ranging source within the reception mask shall not exceed $2.3x10^{-6}$ in any 15-second interval.

3.1.3.3 Latent Failures Affecting Continuity

If redundant equipment is used to meet the requirements in Sections 3.1.3.1 and 3.1.3.2, compliance shall account for the probability that the redundant equipment has failed.

3.1.4 States and Modes

3.1.4.1 States

The LGF shall provide the following two states:

a. LGF On: Main or supplemental power is applied to the LGF equipment and

b. LGF Off: No power is applied to the LGF equipment.

Only one state shall exist at a time.

3.1.4.2 Modes

The LGF shall provide the following modes while in the On State:

a. Normal,

b. Not Available, and

c. Test.

There are no modes when the LGF is in the Off State.

Only one mode shall exist at a time. The LGF shall automatically transition from Normal to Not Available when there is an alarm condition.

3.1.4.3 Normal Mode

The LGF shall be in the Normal Mode when Test Mode has not been commanded and an alarm does not exist. The capability for the following conditions and actions to coexist within the Normal Mode shall include, but is not limited to:

a. Conditions:

  1. Alert (Section 3.1.5.1.2)

  2. Service Alert (Section 3.1.5.1.3)

   3. Constellation Alert (Section 3.1.5.1.4)

b. Actions:

   1. Approach Control (Sections 3.3.2.3.15 & 3.3.2.5.1)
   2. Periodic Maintenance (Section 3.3.1.6.3)
   3. Non-intrusive diagnostics (Section 3.3.2.3.19)
   4. LRU Replacement (Section 3.3.1.6.2.2)
   5. Data Recording (Section 3.3.3)
   6. Status monitoring (Sections 3.3.2.3.2, .3, .4, .7 - .9, .12, .14, .16, .18, & .20)
   7. User ID and password change (Section 3.3.1.7.2)
   8. Adjustment storage (Section 3.3.2.3.21)
   9. Fault recovery (Section 3.1.5.1.1)

c. Transition Criteria:

   1. Entering Normal Mode:
      a) Enter Normal Mode from Off State (power applied)
      b) Enter Normal Mode from Test Mode (Normal Mode commanded)
      c) Enter Normal Mode from Not Available Mode (Auto reset or Fault recovery commanded)
   2. Exiting Normal Mode:
      a) Exit Normal Mode to Not Available Mode (alarm)
      b) Exit Normal Mode to Test Mode (Test Mode commanded)

3.1.4.4 Not Available Mode

The LGF shall be in the Not Available Mode when an alarm exists and when it is not in Test Mode. The capability for the following conditions and actions to coexist within the Not Available Mode shall include, but is not limited to:

a. Condition:

   1. Alarm (Section 3.1.5.1.5)

b. Actions:

   1. Automatic Restart (Section 3.1.5.1.5.1)
   2. States and modes display (Section 3.1.4)
   3. System power display (Section 3.3.2.3.7)
   4. System events recording (Section 3.3.3.1)

c. Transition Criteria:

   1. Entering Not Available Mode:

a) Enter Not Available Mode from Normal Mode (alarm)

b) Enter Not Available Mode from Test Mode

2. Exiting Not Available Mode:

a) Exit Not Available Mode to Normal Mode (following auto restart or fault recovery)

b) Exit Not Available Mode to Test Mode (Test Mode commanded)

3.1.4.5 Test Mode

Test Mode shall be defined as when the LGF is undergoing either maintenance or test. While in Test Mode, the VDB shall be capable of broadcasting all message types as if in the Normal or Not Available Mode. The LGF shall enter Test Mode when commanded by a maintenance specialist. The capability for the following conditions and actions to coexist within the Test Mode shall include, but is not limited to:

a. Conditions:

1. Alert (Section 3.1.5.1.2)
2. Service Alert (Section 3.1.5.1.3)
3. Constellation Alert (Section 3.1.5.1.4)
4. Alarm (Section 3.1.5.1.5)

b. Maintenance and test actions:

1. Restart the LGF (Section 3.3.2.3.1.1)
2. Intrusive and non-intrusive diagnostic control (Section 3.3.2.3.19)
3. Trouble shooting (Section 3.3.1.5)
4. Site specific parameter change (Sections 3.3.2.3.6 & 3.3.2.3.13)
5. Alert, service alert, constellation alert, and alarm threshold change (Section 3.3.2.3.10)
6. Redundant equipment status change (Section 3.3.2.3.17)
7. Monitor by-pass (Section 3.3.2.3.11)
8. VDB by-pass (Section 3.3.2.3.5)
9. Approach control (Section 3.3.2.3.15 & 3.3.2.5.1)
10. Periodic maintenance (Section 3.3.1.6.3)
11. LRU replacement (Section 3.3.1.6.2.2)
12. Data recording (Section 3.3.3)
13. Status monitoring (Sections. 3.3.2.3.2, .3, .4, .7 - .9, .12, .14, .16, .18, & .20)
14. User ID and password change (Section 3.3.1.7.2)

15. Adjustment storage (Section 3.3.2.3.21)

16. Fault recovery (Section 3.1.5.1.1)

c. Transition Criteria:

1. Entering Test Mode:

   a) Enter Test Mode from Normal Mode (Test Mode commanded)

   b) Enter Test Mode from Not Available Mode

2. Exiting Test Mode:

   a) Exit Test Mode to Normal Mode (Normal Mode commanded)

   b) Exit Test Mode to Not Available Mode

Upon exiting the Test Mode, the LGF shall revert to either the Normal or Not Available Mode, depending on the existence of an alarm.

The following figure, Figure 3-3, illustrates the allowable conditions and actions within LGF States and Modes.

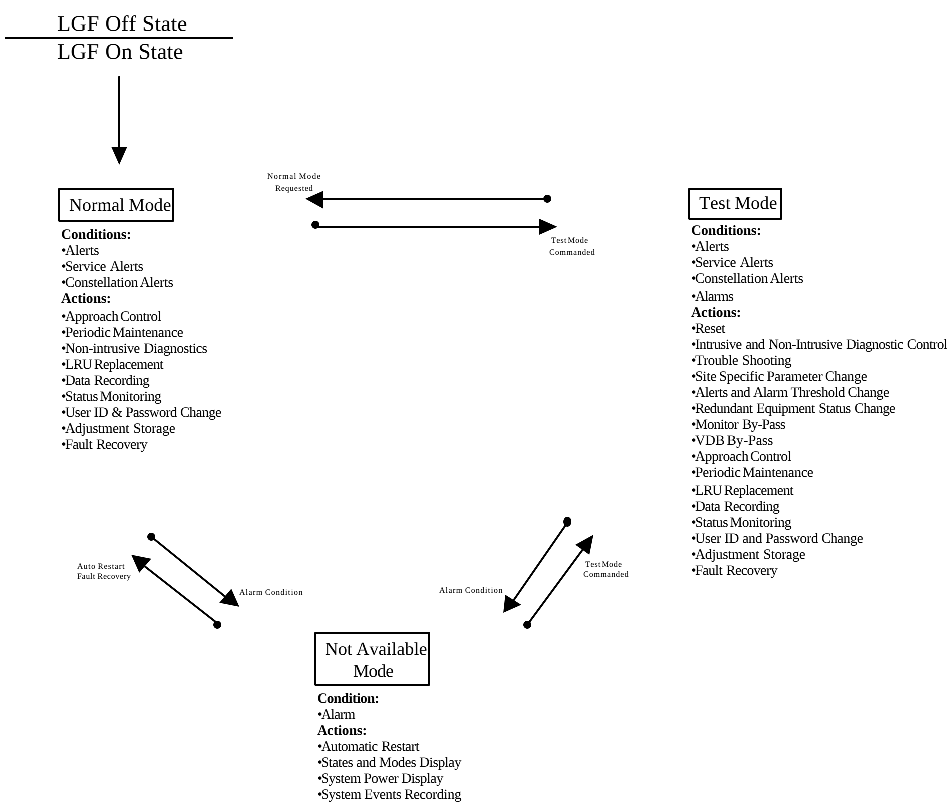


Figure 3-3. Local Area Augmentation System: States and Modes

3.1.5 Executive Monitoring

3.1.5.1 Fault Monitoring

The LGF shall take the identified action for each fault condition identified in Table 3-1 and Table 3-2. Additional performance checks and system monitors may be required to meet the integrity requirements of Sections 3.1.2.2 and 3.1.2.3.

Table 3-1. Fault Conditions and Actions

Section	Fault	Action
Ranging Source		
3.2.1.2.7.3.1 (a)	Signal deformation	Exclude ranging source from Type 1 Message broadcast.
3.2.1.2.7.3.1 (b)/ 3.2.1.2.7.3.2 (a)	Radio Frequency Interference	Exclude PR_{mn}[1] from Pseudorange Correction (PRC) and B-value calculation, exclude ranging source from Type 1 Message broadcast, or exclude all measurements from RR from PRC and B-value calculation.
3.2.1.2.7.3.1 (c)/ 3.2.1.2.7.3.2 (b)	Signal level below threshold	Exclude ranging source from Type 1 Message broadcast.
3.2.1.2.7.3.1 (d)/ 3.2.1.2.7.3.2 (c)	Code and carrier divergence	Exclude ranging source from Type 1 Message broadcast.
3.2.1.2.7.3.1 (e)/ 3.2.1.2.7.3.2 (d)	Excessive acceleration, step, or other rapid changes on code or carrier	Exclude ranging source from Type 1 Message broadcast.
Corrections		
3.2.1.2.7.5.6.1 (a)	Filters converged	Exclude PR_{mn}[1] from PRC and B-value calculation.
3.2.1.2.7.5.6.1 (b, c)	B-value exceeds limit	Exclude PR_{mn}[1] from PRC and B-value calculation.
3.2.1.2.7.5.6.1(d)	Pseudorange correction exceeds limit	Exclude ranging source from Type 1 Message broadcast.
3.2.1.2.7.6.1	Pseudorange correction rate exceeds limit	Exclude ranging source from Type 1 Message broadcast.
3.2.1.2.7.6.1.1	Faulted σ_{prr}	Exclude PR_{mn}[1] from PRC and B-value calculation, exclude ranging source from Type 1 Message broadcast, or exclude all measurements from RR from PRC and B-value calculation.
3.2.1.2.7.7.1	Faulted σ_{pr_lgf}	Exclude PR_{mn}[1] from PRC and B-value calculation, exclude ranging source from Type 1 Message broadcast, or exclude all measurements from RR from PRC and B-value calculation.
Data Broadcast		
3.2.3 (a)	Disagreement between transmitted data	Terminate VDB output.
3.2.3 (b)	On-channel assigned power exceeds limits	Terminate VDB output.
3.2.3 (c)	0.2% of messages not transmitted in last hour	Terminate VDB output.
3.2.3 (d)	No transmission for 3 seconds	Terminate VDB output.
3.2.3 (e)	Transmitted data outside of assigned Time Division Multiple Access (TDMA) time slots	Terminate VDB output.

[1] Pseudorange (PR), where *m* indicates an individual RR and *n* indicates an individual ranging source.

Table 3-2. Valid GPS and SBAS Navigation Data

Section	Fault	Action
3.2.1.2.7.3.3:		
(a)	Failed parity	Exclude GPS ranging source from Type 1 Message broadcast
(b)	Bad IODC	Exclude GPS ranging source from Type 1 Message broadcast
(c)	HOW bit 18 set to “1”	Exclude GPS ranging source from Type 1 Message broadcast
(d)	Data bits in subframes 1, 2, or 3 set to “0”	Exclude GPS ranging source from Type 1 Message broadcast
(e)	Subframes 1, 2, or 3 set to default	Exclude GPS ranging source from Type 1 Message broadcast
(f)	Preamble incorrect	Exclude GPS ranging source from Type 1 Message broadcast
(g)	Navigation data inconsistent between RRs	Exclude GPS ranging source from Type 1 Message broadcast
(h)	Almanac differs from ephemeris by more than 7000 m at any point	Exclude GPS ranging source from Type 1 Message broadcast
(i)	After valid corrections computed, PRC or PRC rate exceeds limit	Exclude GPS ranging source from Type 1 Message broadcast
(j)	Receive “Do Not Use” SBAS message	Exclude GPS ranging source from Type 1 Message broadcast
(k)	Ephemeris CRC changes and IODE does not	Exclude GPS ranging source from Type 1 Message broadcast
(l)	GPS PRN = 37	Exclude GPS ranging source from Type 1 Message broadcast
	Ephemeris not consistent to within 250 m	Exclude GPS ranging source from Type 1 Message broadcast
3.2.1.2.7.3.4:		
(a)	Failed parity	Exclude SBAS ranging source from Type 1 Message broadcast
(b)	Navigation data inconsistent between RRs	Exclude SBAS ranging source from Type 1 Message broadcast
(c)	Almanac differs from ephemeris by more than 200 km at any point	Exclude SBAS ranging source from Type 1 Message broadcast
(d)	SBAS positions changes more than 0.12 m in 4 minutes	Exclude SBAS ranging source from Type 1 Message broadcast
(e)	No SBAS navigation message for 4 minutes	Exclude SBAS ranging source from Type 1 Message broadcast
(f)	After valid corrections computed, PRC or PRC rate exceeds limit	Exclude SBAS ranging source from Type 1 Message broadcast
(g)	Receive ‘Do Not Use” SBAS message	Exclude SBAS ranging source from Type 1 Message broadcast

3.1.5.1.1 Fault Recovery

Upon exclusion of a single measurement, ranging source, or RR the LGF shall continue to monitor the excluded single measurement, ranging source, or RR. For ranging source faults and correction faults in Table 3-1, except as noted in Section 3.2.1.2.7.7.1, the LGF shall re-introduce the excluded single measurement, ranging source, or RR when the fault no longer exists. After detecting a ranging source fault, the probability of re-introducing the excluded single measurement, ranging source, or RR when the fault condition persists shall be less than 1.94×10^{-9}.

3.1.5.1.2 Generation of Alerts

The LGF shall generate an alert upon detecting a fault that does not affect the ability of the system to meet the integrity requirements of Section 3.1.2. Faults shall include the ranging source and correction faults identified in Tables 3-1, navigation data in Table 3-2, and environmental sensor conditions exceeding the limits defined in Section 3.3.1.4. Alert thresholds shall be defined during the design process.

3.1.5.1.3 Generation of Service Alerts

A service alert is defined as a fault that could affect LGF service and requires corrective maintenance. Service alert thresholds shall be defined during the design process.

3.1.5.1.3.1 Continuity Faults

A service alert shall be generated when the LGF is unable to insure that the continuity requirements of Section 3.1.3 can be met due to a fault in any of the following items:

a. main and standby Line Replaceable Units (LRU)s,

b. hardware components,

c. internal firmware, and

d. uninteruptable power supply.

3.1.5.1.3.2 Environmental Faults

A service alert shall be generated when the thresholds for the following environmental sensors are exceeded:

a. smoke detector (Section 3.3.1.4.2),

b. Alternating Current (AC) power (Section 3.3.1.4.4), and

c. inside temperature (Section 3.3.1.4.5).

3.1.5.1.4 Generation of Constellation Alerts

A constellation alert shall be generated 20 minutes ± 1 minute before a loss of service availability. Only losses of service predicted to be longer than 1 minute shall cause a constellation alert. Constellation alerts shall be based on aircraft equipage with Aircraft Accuracy Designator B LAAS avionics. The probability that an ATCU provides a constellation alert while service is available shall be less than $1x10^{-2}$. The probability that an ATCU is not provided with a constellation alert while service is not available shall be less than $1x10^{-2}$.

3.1.5.1.5 Generation of Alarms

The LGF shall generate an alarm when integrity requirements of Section 3.1.2 can not be guaranteed. The LGF shall generate an alarm when the VDB monitor has detected any fault identified in Section 3.2.3. When an alarm is generated, the action in 'a' or actions in 'a' and 'b' shall be taken:

a. the Number of Measurements Field is set to zero in the Type 1 Message or

b. the VDB output is terminated.

Alarm thresholds shall be defined during the design process.

3.1.5.1.5.1 Automatic Restart

The LGF shall attempt an automatic restart following an alarm at 3 minutes ± 1 minute. If an alarm condition still exists following the restart attempt, restart shall be available only through manual command via the MDT.

3.1.6 Software Design Assurance

All LGF software functions shall be compliant with the guidelines and objectives of the applicable software level specified in “Software Considerations in Airborne Systems and Equipment Certification” (RTCA/DO-178B, 1993).

All software for the LGF shall be Year 2000 (Y2K) compliant. All software for the LGF shall accommodate any date between December 31, 1999 and December 31, 2049.

3.1.7 Complex Electronic Hardware Design Assurance

Complex electronic hardware devices including, but not limited to, Application Specific Integrated Circuits (ASICs) and Programmable Logic Devices (PLDs), shall be produced with structured development, verification, configuration management, and quality assurance processes.

The level of production process rigor associated with complex electronic hardware shall be based on the contribution of the hardware to potential failure conditions as determined by the System Safety Assessment (SSA) process.

All hardware for the LGF shall be Y2K compliant. All hardware for the LGF shall accommodate any date between December 31, 1999 and December 31, 2049.

3.2 Data Broadcast

3.2.1 Broadcast Data Requirements

All message types and fields shall be in accordance with the field definitions, formats, and protocols of "GNSS Based Precision Approach Local Area Augmentation System (LAAS) Signal-in-Space Interface Control Document (ICD)" (RTCA/DO-246, 1998), except as noted in Appendix H.

All static parameters to be broadcast and default values shall be stored in the LGF Non-Volatile Memory (NVM). NVM storage shall be a minimum of 90 days without power applied.

3.2.1.1 Local Area Augmentation System Message Block

The LGF shall transmit the LAAS message block. The LAAS message block consists of the Message Block Header, the Message, and the Cyclic Redundancy Check (CRC).

3.2.1.1.1 Message Block Header

3.2.1.1.1.1 Message Block Identifier

The LGF shall set the Message Block Identifier Field to 1010 1010 when not in Test Mode and to 1111 1111 when the LGF is in Test Mode.

3.2.1.1.1.2 Ground Station Identification

The Ground Station Identification Field shall denote the LGF station Identification (ID) stored in LGF NVM.

3.2.1.1.1.3 Message Type Identifier

The Message Type Identifier Field shall only denote Message Types 1, 2, or 4.

3.2.1.1.1.4 Message Length

The Message Length Field shall denote the number of 8-bit words in the message block. The message length includes the header, the message, and the CRC field.

3.2.1.1.2 Message

The LGF shall transmit message types 1, 2, and 4.

3.2.1.1.3 Cyclic Redundancy Check

The CRC Field shall denote the CRC calculated on the message header and the message.

3.2.1.2 Type 1 Message – Differential Corrections

The LGF shall broadcast the Type 1 Message once each frame. The LGF shall provide the capability to generate the ranging source measurement block for 18 ranging sources. Broadcast of the Type 1 Message shall occur no later than 0.5 seconds after the time indicated by the Modified Z-count, corresponding to the corrections.

3.2.1.2.1 Modified Z-Count

The Modified Z-count Field shall denote the reference time for all the message parameters in the Type 1 Message.

3.2.1.2.2 Additional Message Flag

The Additional Message Flag Field shall denote that additional messages are not provided.

3.2.1.2.3 Number of Measurements

The Number of Measurements Field shall denote the number of ranging source measurement blocks broadcast in the Type 1 Message.

3.2.1.2.4 Measurement Type

The Measurement Type Field shall denote the measurement type is GPS L1 C/A code.

3.2.1.2.5 Ephemeris Cyclic Redundancy Check

The Ephemeris CRC Field shall apply the CRC computed for the ranging source associated with the first ranging source measurement block in the Type 1 Message.

3.2.1.2.6 Source Availability Duration

The Source Availability Duration Field shall denote the period that the ranging source will remain within the reception mask associated with the first ranging source measurement block relative to the Modified Z-count.

3.2.1.2.6.1 Reception Mask

The reception mask for the LGF shall define the region where corrections from ranging source signals are broadcast. The nominal mask shall include all elevations from 5° to 90° and all azimuths from 0° to 360°, excluding the blockage effects of any obstacle protruding from the horizontal plane.

3.2.1.2.7 Ranging Source Measurement Block

The first ranging source in the message shall sequence so that the ephemeris CRC and source availability duration for each ranging source is transmitted at least once every 10 seconds, except when new ephemeris data are received from a ranging source. When new ephemeris data are received from a ranging source, the LGF shall broadcast the new ephemeris data for that ranging source in three consecutive Type 1 Messages. When new ephemeris data are received from more than one ranging source, the first ranging source in the Type 1 Message shall sequence so that the ephemeris CRC and source availability duration for each ranging source are transmitted at least once every 27 seconds.

3.2.1.2.7.1 Ranging Source Identification

The Ranging Source ID Field shall denote the satellite pseudorandom number assigned to the ranging source associated with the ranging source measurement block.

3.2.1.2.7.2 Ranging Signal Sources

The LGF shall be capable of processing

a. GPS SPS signals, as defined in the GPS SPS Signal Specification and

b. SBAS signals, as defined in the Wide Area Augmentation System (WAAS) Specification (FAA-E-2892B).

3.2.1.2.7.3 Conditions for Transmitting the Ranging Source Measurement Block

3.2.1.2.7.3.1 Valid Global Positioning System Ranging Sources

The LGF shall detect ranging source failures, a – e, that cause a pseudorange correction error exceeding the values in Table 3-3 for all allowable airborne configurations defined in Appendix E. The probability of missed detection for each failure, a – e, shall be $\leq 1 \times 10^{-3}$. The LGF shall cease broadcast of a failed ranging source measurement block within 3 seconds of the onset of the failure. Prior to broadcast of pseudorange corrections for a ranging source when it enters the reception mask, the LGF shall detect each failure, a – e, with a missed detection probability of $\leq 1.1 \times 10^{-4}$:

a. The ranging source is distorted by any of the following:

   1. Each falling edge of the positive chips in the C/A code is delayed by Δ seconds, where $0 \leq \Delta \leq 120$ nanoseconds.

   2. Each falling edge of the positive chips in the C/A code is advanced by Δ seconds, where $0 \leq \Delta \leq 120$ nanoseconds.

   3. The distorted C/A code is the output of a second order linear system that has the standard C/A code as an input. The system is characterized by a damping factor, σ, and a resonant frequency, f_d, as shown:

$$\text{C/A Code} \longrightarrow \boxed{\dfrac{(2\pi f_0)^2}{s^2 + 2\sigma s + (2\pi f_0)^2}} \longrightarrow \text{Distorted C/A Code} \qquad (1)$$

where $f_0 = \dfrac{1}{2\pi}\sqrt{\sigma^2 + (2\pi f_d)^2}$ and (2)

s is the complex frequency used in Laplace transforms.

Each step, e_0, in the input C/A sequence results in a second order step response that is given by

$$e(t) = e_0\left\{1 - \exp(-\sigma t)\left[\cos 2\pi f_d t + \frac{\sigma}{2\pi f_d}\sin 2\pi f_d t\right]\right\}, \qquad (3)$$

for this waveform,

$0.8\text{x}10^6 \le \sigma \le 8.8\text{x}10^6$ nepers/second
$4\text{x}10^6 \le f_d \le 17\text{x}10^6$ cycles/second.

4. The distorted C/A code is the output of a second order linear system characterized by a damping factor and a resonant frequency with an input of a modified standard C/A code, where every falling edge of the positive chip in the modified C/A code is

a) delayed by Δ seconds, where $0 \le \Delta \le 120$ nanoseconds

b) advanced by Δ seconds, where $0 \le \Delta \le 120$ nanoseconds

$$\text{C/A Code} \longrightarrow \boxed{\begin{array}{c}\text{Falling edge}\\ \text{lead/lag } \Delta\end{array}} \xrightarrow{\text{Modified C/A Code}} \boxed{\dfrac{(2\pi f_0)^2}{s^2 + 2\sigma s + (2\pi f_0)^2}} \longrightarrow \text{Distorted C/A Code}$$

(4)

This waveform has the combined effects of items 1, 2, and 3, but the damping factor and resonant frequency are varied over a smaller range, specifically:

$0.8\text{x}10^6 \le \sigma \le 8.8\text{x}10^6$ nepers/second
$7.3\text{x}10^6 \le f_d \le 13\text{x}10^6$ cycles/second.

b. Radio Frequency (RF) Interference (RFI) in excess of levels defined in Appendix A;

c. Signal levels below those specified in Section 2.3.4 of the GPS SPS Signal Specification;

d. Code and carrier divergence; and

e. Excessive acceleration, such as step or other rapid changes, of the code and carrier phases on the differential correction process.

Table 3-3. Error Values – Global Positioning System

Failure Condition	Value
a	$5.8\ s_{pr\_lgf,n}$
b	$\frac{4.9}{\sqrt{N'}} s_{pr\_lgf,n}$ (5)
c, d, and e	$4.9\ s_{pr\_lgf,n}$

where $s_{pr\_lgf,n}$ is for the n[th] ranging source, as defined in Section 3.2.1.2.7.7,

n is the ranging source index, and

N' has two values:
N' is equal to 1 when there is interference on zero or one ranging source and
N' is equal to the number of ranging sources in the last broadcast Type 1 Message when there is interference on two or more ranging sources.

3.2.1.2.7.3.2 Valid Space Based Augmentation System Ranging Sources

The LGF shall detect ranging source failures, a – d, that cause a pseudorange correction error exceeding the values in Table 3-4. The probability of missed detection shall be $\leq 1x10^{-3}$. The LGF shall cease broadcast of a failed ranging source measurement block within 3 seconds of the onset of the failure. Prior to broadcast of pseudorange corrections for a ranging source when it enters the reception mask, the LGF shall detect failures, a – d, with a missed detection probability of $\leq 1.3x10^{-4}$.

a. RFI in excess of levels defined in Appendix A;

b. Signal levels below those specified in Appendix 2, Section 2.6.5 of FAA-E-2892B;

c. Code and carrier divergence; and

d. The impact of excessive acceleration, such as step or other rapid changes, of the code and carrier phases on the differential correction process.

Table 3-4. Error Values – Space Based Augmentation System

Failure Condition	Value
a	$\frac{4.9}{\sqrt{N'}} s_{pr\_lgf,n}$ (6)
b, c, d	$4.9\ s_{pr\_lgf,\ n}$

3.2.1.2.7.3.3 Valid Global Positioning System Navigation Data

The LGF shall not broadcast the ranging source measurement block if

a. three or more parity errors have been detected in the previous 6 seconds, in accordance with the parity algorithm equations defined in Section 2.5.2 of the GPS SPS Signal Specification;

b. broadcast Issue of Data (IOD) Ephemeris (IODE) does not match eight least-significant bits of broadcast IOD Clock (IODC);

c. bit 18 of the Hand-over-Word (HOW) is set to 1 (Section 2.4.2.2 of the GPS SPS Signal Specification);

d. all data bits are zeros in subframes 1, 2, or 3;

e. default navigation data are being transmitted in subframes 1, 2, or 3 for that satellite (Section 2.4.1.3 of the GPS SPS Signal Specification);

f. the preamble does not equal 8B (hexadecimal);

g. the same ephemeris and clock data were not used by all RRs to compute the PRC;

h. any point on the orbit defined by the broadcast ephemeris is more than 7000 m from the orbit defined by the broadcast almanac;

i. after valid corrections were computed by the LGF, the pseudorange correction bound (Section 3.2.1.2.7.5.6.1 [d]) or the pseudorange correction rate bound (Section 3.2.1.2.7.6.1) was exceeded at any time using the broadcast ephemeris data;

j. an SBAS within the reception masks broadcasts a Message Type 2 – 5 and 24 indicating "Do Not Use This GPS Satellite" as defined in Section 2.1.1.4.3 of RTCA/DO-229A;

k. the ephemeris CRC changes and the IODE does not; or

l. the decoded GPS PRN is 37.

A new ephemeris shall be compared to the previously broadcast ephemeris, if available, and is validated if the difference in satellite position is less than 250 m and none of the conditions a – k exists. Ephemerides shall be validated and applied within 3 minutes of receiving a new set, but not before they have been continuously present for 2 minutes.

3.2.1.2.7.3.4 Valid Space Based Augmentation System Navigation Data

The LGF shall not broadcast the ranging source measurement block if

a. three or more parity errors have been detected in the previous 6 seconds, in accordance with the parity algorithm equations defined in Appendix 2, Section 4.3.3 of FAA-E-2892B;

b. the same ephemeris and clock data were not used by all RRs to compute the PRC;

c. the satellite position defined by the broadcast ephemeris is more than 200 km from the satellite position defined by the broadcast almanac;

d. the differences between satellite positions defined by any of the SBAS navigation messages broadcast in the previous 4 minutes is greater than 0.12 m;

e. more than 4 minutes have elapsed since reception of the SBAS navigation message;

f. after valid corrections were computed by the LGF, the pseudorange correction bound (Section 3.2.1.2.7.5.6.1 [d]) or the pseudorange correction rate bound (Section 3.2.1.2.7.6.1) was exceeded at any time using the broadcast ephemeris data; or

g. the SBAS satellite for which the ranging source measurement block provides a correction broadcasts a Message Type 0 indicating "Do Not Use This SBAS Signal" as defined in Section 2.1.1.4.1 of RTCA/DO-229A.

After confirming that none of the conditions a – g exists, new SBAS navigation data shall be used for subsequent measurements.

3.2.1.2.7.4 Issue of Data

The IOD Field shall denote the IODE for GPS or IOD for SBAS associated with the ephemeris data used to determine the broadcast correction.

3.2.1.2.7.5 Pseudorange Corrections

The Pseudorange Correction Field shall denote the broadcast pseudorange correction.

3.2.1.2.7.5.1 Smoothed Pseudorange

In steady state, each pseudorange measurement from each RR shall be smoothed using the filter

$$PR_s(k) = \left(\frac{1}{N}\right) PR_r(k) + \left(\frac{N-1}{N}\right)\left[PR_s(k-1) + \phi(k) - \phi(k-1)\right] \qquad (7)$$

$$N = S/T$$

where PR_r is the raw pseudorange,

PR_s is the smoothed pseudorange,

N is the number of samples,

S is the time filter constant, equal to 100 seconds,

T is the filter sample interval, nominally equal to 0.5 seconds and not to exceed 1 second,

ϕ is the accumulated phase measurement,

k is the current measurement, and

$k\text{-}1$ is the previous measurement.

The raw pseudorange shall be determined under the following conditions:

a. Correlator spacing between the early and the late correlators are 0.1 chip width $\pm$ 0.02.

b. The code loop is carrier driven and of first order, or higher, and has a one-sided noise bandwidth $\geq$ 0.125 Hz.

c. The strongest correlation peak is acquired taking into account the affect of any secondary peak found at any code offset within the entire code sequence.

3.2.1.2.7.5.2 Global Positioning System Predicted Range

The predicted range to each GPS ranging source shall be computed from the corresponding RR antenna phase center location and the validated ephemeris. The ephemeris shall be determined in accordance with Section 2.5.4 of the GPS SPS Signal Specification.

3.2.1.2.7.5.3 Space-Based Augmentation System Predicted Range

The predicted range to each SBAS ranging source shall be computed from the corresponding RR antenna phase center location and the validated ephemeris. The position of the ranging source shall be determined in accordance with Appendix 2, Section 4.4.11 of FAA-E-2892B.

3.2.1.2.7.5.4 Global Positioning System Smoothed Pseudorange Correction

The smoothed pseudorange correction (PR_{sc}) for a GPS ranging source shall be calculated using the equation

$$PR_{sc} = R - PR_s - t_{sv\_gps} \tag{8}$$

where R is the predicted range and

t_{sv_gps} is the correction due to the satellite clock from the decoded GPS Navigation Data in accordance with the algorithms given in Sections 2.5.5.1 and 2.5.5.2 of the GPS SPS Signal Specification.

Ionospheric and tropospheric corrections shall not be applied to the smoothed pseudorange correction.

3.2.1.2.7.5.5 Space-Based Augmentation System Smoothed Pseudorange Correction

The smoothed pseudorange correction (PR_{sc}) for an SBAS ranging source shall be calculated using the equation

$$PR_{sc} = R - PR_s - t_{sv\_sbas} \tag{9}$$

where t_{sv_sbas} is the correction due to the satellite clock from the decoded WAAS Navigation Data Message Type 9 in accordance with the algorithm given in Appendix 2, Section 4.4.11 of FAA-E-2892B.

3.2.1.2.7.5.6 Broadcast Correction

The broadcast correction shall be calculated using the equations

$$PR_{corr}(n) \equiv \frac{1}{M(n)} \sum_{m \in s_n} PR_{sca}(n,m) \text{ and} \tag{10}$$

$$PR_{sca}(n,m) \equiv PR_{sc}(n,m) - \frac{1}{N_c} \sum_{n \in s_c} PR_{sc}(n,m). \tag{11}$$

where PR_{corr} is the broadcast correction;

$M(n)$ is the number of elements in set S_n;

PR_{sca} is the carrier smoothed and receiver clock adjusted pseudorange correction;

n is the satellite index;

S_n is the set of RRs with valid measurements for satellite n;

m is the RR index;

S_c is the set of valid ranging sources tracked by all RRs; and

N_c is the number of elements in set S_c;

given the following conditions:

a. if N_c is less than four, no corrections shall be provided in the Type 1 Message,

b. M shall be at least three for the fault free configuration,

c. each RR measurement (m,n) used to determine the broadcast corrections shall be updated at no less than a 2 Hz rate, and

d. each RR measurement (m,n) used to determine the broadcast corrections shall be based on identical signal processing techniques and tracking loop characteristics.

3.2.1.2.7.5.6.1 Correction Errors

The LGF shall broadcast the ranging source measurement block when

a. smoothing filters have converged such that the magnitude of the one σ pseudorange correction error does not exceed 10 cm;

b. the magnitude of the associated B-values does not exceed $\frac{5.6\sigma_{pr\_lgf}}{\sqrt{M(n)-1}}$ (12)

for GPS ranging sources;

c. the magnitude of the associated B-values does not exceed $\frac{5.6(\sigma_{pr\_lgf}-0.15)}{\sqrt{M(n)-1}}$ (13)

for SBAS ranging sources; and

d. the magnitude of the pseudorange correction does not exceed 327.67 m.

3.2.1.2.7.6 Pseudorange Correction Rate

The Pseudorange Correction Rate Field shall indicate the pseudorange correction rate, defined to be PRR_{corr}, based on the current and immediately prior broadcast corrections. The current and immediately prior broadcast corrections shall compensate for changes in S_c and ephemeris changes to eliminate rate spikes.

3.2.1.2.7.6.1 Condition for Valid Pseudorange Correction Rate

The LGF shall not broadcast the ranging source measurement block if

a. the pseudorange correction rate exceeds ±3.4 m per second or

b. the standard deviation of the error in the pseudorange correction rate, defined to be σ_{prr}, exceeds 4.0 cm per second.

3.2.1.2.7.6.1.1 Pseudorange Correction Rate Monitor

The LGF shall not broadcast the ranging source measurement block if

$$B_{PRR} > 5.6\sigma_{prr}\left(\sqrt{M(n)-1}\right)^{-1} \qquad (14)$$

where $B_{PRR}(n,m) = PRR_{corr}(n) - \frac{1}{M(n)-1}\sum_{\substack{i\in S_n \\ i\notin m}} PRR_{sca}(n,i)$, given that (15)

PRR_{sca} is the carrier smoothed and receiver clock adjusted pseudorange correction rate for an individual receiver that is compensated for changes in S_c and ephemeris and

σ_{prr} is the one sigma pseudorange correction rate error that is established at installation.

3.2.1.2.7.7 Sigma Pseudorange Ground

The σ_{pr_gnd} shall be broadcast for each ranging source so that

$$\sigma_{pr\_gnd} = \sqrt{\sigma_{pr\_lgf}^{2} + \sigma_{spatial\_dec}^{2}} \qquad (16)$$

where $\sigma_{spatial\_dec}$ is stored in the LGF NVM and

σ_{pr_lgf} is defined for each ranging source so that

a. the Vertical Protection Limit $(VPL)_{H0}$ and Lateral Protection Limit $(LPL)_{H0}$ bound the user position error with an integrity risk not greater than those indicated in Table 3-5 for a user located at the LGF reference point, given that the LGF is fault free and the local multipath environment is consistent with that described in the installation guidelines,

b. the VPL_{H1} and LPL_{H1} bound the user position error with an integrity risk not greater than those indicated in Table 3-5 for a user located at the LGF reference point, given that an undetected failure from a RR exists that affects the smoothed pseudorange corrections (PR_{sca}), and

where VPL_{H0}, LPL_{H0}, VPL_{H1}, and LPL_{H1} are computed in accordance with Section 3.1.3.4.6 of RTCA/DO-245 with the exception that $\sigma_{pr\_gnd} \equiv \sigma_{pr\_lgf}$; the user position is calculated in accordance with Section 3.1.3.4.5 of RTCA/DO-245 using any combination of four or more ranging sources; and the airborne contribution to the corrected pseudorange error is assumed to be zero.

Table 3-5. Sigma Pseudorange Ground Detection Probabilities

Integrity Risk (probability)	Maximum Number of Reference Receivers used to Formulate the Broadcast Pseudorange Corrections used in the Associated Position Solution		
	2	3	4
a. Fault free missed detection	8.33×10^{-9}	6.25×10^{-9}	5.01×10^{-9}
b. Missed detection	1.67×10^{-3}	1.88×10^{-3}	2.00×10^{-3}

Under the minimum signal strength defined in Section 2.3.4 of the GPS SPS Signal Specification and the standard interference environment defined in Appendix A, the accuracy of the LGF shall be such that conditions a and b are met and

$$\sigma_{pr\_lgf}(\theta_n) \le c_0 \left(\sqrt{\frac{\left(a_0 + a_1 e^{-\theta_n/\theta_0}\right)^2}{M} + (a_2)^2} \right) + b_0 \tag{17}$$

where θ_n is the n^{th} ranging source elevation angle,

a_0, a_1, a_2, θ_0, b_0, and c_0 are the coefficients for the applicable Accuracy Designator defined in Table 3-6, and

M is the number of corrections per ranging source.

Table 3-6. Accuracy Designator Coefficients

		a_0 meters	a_1 meters	a_2 meters	θ_0 degrees	b_0 meters	c_0
Accuracy Designator B							
	GPS Satellites	0.16	1.07	0.08	15.5	0	1.0
	SBAS Satellites	0.16	1.07	0.08	15.5	0.15	1.91
Accuracy Designator C							
	GPS Satellites $\theta_n \geq 35°$	0.15	0.84	0.04	15.5	0	1.0
	GPS Satellites $\theta_n < 35°$	0.24	0	0.04	-	0	1.0
	SBAS Satellites $\theta_n \geq 35°$	0.15	0.84	0.04	15.5	.15	1.91
	SBAS Satellites $\theta_n < 35°$	0.24	0	0.04	-	.15	1.91

The accuracy requirement shall be met within the reception mask given in Section 3.2.1.2.6.1. The selection of the parameters in Table 3-6 to which the LGF is designed will affect the operational availability of the LGF and shall be used to determine the accuracy designator, B or C, used in the Accuracy Designator Field.

3.2.1.2.7.7.1 Condition for Valid Sigma Pseudorange LGF

The LGF shall detect conditions that result in noncompliance with conditions 'a' and 'b' in Section 3.2.1.2.7.7. If the increase in system risk associated with degraded performance is minimal, but exceeds design tolerances, the LGF shall initiate a service alert. The probability of a false service alert shall be adjustable, but set to achieve a nominal false alert rate of 10^{-4} per hour. If the increase in system risk is not minimal, the LGF shall exclude the offending RR or shut-down the VDB, as appropriate. An alarm shall be issued when the VDB is shut-down, and a service alert shall be issued when a RR is excluded. Self-recovery shall not be applied in either case. The probability of false RR exclusion or VDB shut-down shall equal 10^{-7} per 15-second interval. In detecting these conditions, LGF performance over the previous one hour, one day, one month, and since initialization shall be used. Monitored parameters shall include the distribution of B-values and correlation between RRs.

3.2.1.2.7.8 B-Values

The B-Value Field shall denote the B-value calculated using the equation

$$B_{PR}(n,m) \equiv PR_{corr}(n) - \frac{1}{M(n)-1} \sum_{\substack{i \in S_n \\ i \neq m}} PR_{sca}(n,i) \qquad (18)$$

where $B_{PR}(n,m)$ is the estimate of the error contribution to the average correction from RR m.

3.2.1.3 Type 2 Message – Differential Reference Point

The LGF shall broadcast the Type 2 Message at least once every 10 seconds.

3.2.1.3.1 Installed Receivers

The Installed Receivers Field shall denote the number of installed receivers stored in LGF NVM.

3.2.1.3.2 Accuracy Designator

The Accuracy Designator Field shall denote the accuracy designator stored in LGF NVM.

3.2.1.3.3 Continuity and Integrity Designator

The LGF Ground Continuity and Integrity Designator (GCID) Field shall denote the LGF GCID. The LGF GCID shall be 001 when no alarm exists. The LGF GCID shall be 111 when an alarm exists.

3.2.1.3.4 Local Magnetic Variation

The Local Magnetic Variation Field shall denote the local magnetic variation stored in LGF NVM.

3.2.1.3.5 Refractivity Index

The Refractivity Index Field shall denote the refractivity index stored in LGF NVM.

3.2.1.3.6 Scale Height

The Scale Height Field shall denote the scale height stored in LGF NVM.

3.2.1.3.7 Refractivity Uncertainty

The Refractivity Uncertainty Field shall denote the refractivity uncertainty stored in LGF NVM.

3.2.1.3.8 Latitude

The Latitude Field shall denote the LGF reference point latitude stored in LGF NVM.

The LGF reference point shall be defined as the coordinates of a single RR antenna location for each installation.

3.2.1.3.9 Longitude

The Longitude Field shall denote the LGF reference point longitude stored in LGF NVM.

3.2.1.3.10 Vertical Ellipsoid Offset

The Vertical Ellipsoid Offset Field shall denote the LGF reference point height above the WGS-84 ellipsoid stored in LGF NVM.

3.2.1.4 Type 4 Message – Final Approach Segment Data

The Type 4 Message shall include the Data Set Length, Final Approach Segment (FAS) Data Block, the FAS/Vertical Alert Limit (VAL) approach status, and the FAS/Lateral Alter Limit (LAL) approach status. The LGF shall broadcast each FAS data block at least once every 10 seconds.

3.2.1.4.1 Data Set Length

The Data Set Length Field shall denote the Type 4 Message data set length, which indicates the number of bytes in the data set.

3.2.1.4.2 Final Approach Segment Data Block

The Type 4 Message shall contain the FAS data block for each runway approach served by the LGF. The required content of the data block is defined in the following subsections. This block and its corresponding approach performance designator are broadcast depending on the runway end(s) selected at the ATCU, and the MDT when necessary.

3.2.1.4.2.1 Operation Type

The Operation Type Field shall denote the operation type stored in LGF NVM.

3.2.1.4.2.2 Space Based Augmentation System Provider Identification

The SBAS Provider ID Field shall denote the SBAS service provider ID stored in LGF NVM.

3.2.1.4.2.3 Airport Identification

The Airport Identification Field shall denote the airport identification stored in LGF NVM.

3.2.1.4.2.4 Runway Number

The Runway Number Field shall denote the runway number stored in LGF NVM.

3.2.1.4.2.5 Runway Letter

The Runway Letter Field shall denote the runway letter stored in LGF NVM.

3.2.1.4.2.6 Approach Performance Designator

The Approach Performance Designator Field shall denote the approach PT stored in LGF NVM.

3.2.1.4.2.7 Route Indicator

The Route Indicator Field shall denote the route indicator stored in the LGF.

3.2.1.4.2.8 Reference Path Data Selector

The Reference Path Data Selector Field shall denote the reference path data selector stored in LGF NVM.

3.2.1.4.2.9 Reference Path Identifier

The Reference Path Identifier Field shall denote the reference path identifier stored in LGF NVM.

3.2.1.4.2.10 Landing Threshold Point/Fictitious Threshold Point Latitude

The LTP/FTP Latitude Field shall denote the LTP/FTP latitude stored in LGF NVM.

3.2.1.4.2.11 Landing Threshold Point/Fictitious Threshold Point Longitude

The LTP/FTP Longitude Field shall denote the LTP/FTP longitude stored in LGF NVM.

3.2.1.4.2.12 Landing Threshold Point/Fictitious Threshold Point Height

The LTP/FTP Height Field shall denote the LTP/FTP height stored in LGF NVM.

3.2.1.4.2.13 Delta Flight Path Alignment Point Latitude

The Δ FPAP Latitude Field shall denote the Δ FPAP latitude stored in LGF NVM.

3.2.1.4.2.14 Delta Flight Path Alignment Point Longitude

The Δ FPAP Longitude Field shall denote the Δ FPAP longitude stored in LGF NVM.

3.2.1.4.2.15 Approach Threshold Crossing Height

The Approach Threshold Crossing Height (TCH) Field shall denote the TCH stored in LGF NVM.

3.2.1.4.2.16 Approach Threshold Crossing Height Unit Selector

The TCH Units Selector Field shall denote the TCH Unit Selector stored in LGF NVM.

3.2.1.4.2.17 Glidepath Angle

The Glidepath Angle (GPA) Field shall denote the GPA stored in LGF NVM.

3.2.1.4.2.18 Course Width

The Course Width Field shall denote the course width stored in LGF NVM.

3.2.1.4.2.19 Delta Length Offset

The Δ Length Offset Field shall denote the Δ length offset stored in LGF NVM.

3.2.1.4.2.20 Final Approach Segment Cyclic Redundancy Check

The FAS CRC Field shall denote the FAS CRC stored in LGF NVM.

3.2.1.4.3 Final Approach Segment Vertical Alert Limit/Approach Status

The FAS VAL/Approach Status Field shall denote the FAS VAL or “Do Not Use Vertical" stored in LGF NVM. All ones in this field indicate that vertical guidance is not available.

3.2.1.4.4 Final Approach Segment Lateral Alert Limit/Approach Status

The FAS LAL/Approach Status Field shall denote the FAS LAL or “Do Not Use Approach” stored in the NVM. All ones in this field indicate that the approach is not available.

3.2.2 Radio Frequency Transmission Characteristics

3.2.2.1 Symbol Rate

The symbol rate of the LGF data broadcast shall be 10,500 symbols per second ±0.005%. Each symbol defines one of eight states (3 bits) resulting in a nominal bit rate of 31,500 bits per second.

3.2.2.2 Emission Designator

The FCC emission designator of this modulation technique is 14K0G7DET.

3.2.2.3 Antenna Polarization

The LGF shall transmit the VHF signal using right hand elliptically polarized antennas.

3.2.2.4 Field Strength

The Effective Radiated Power (ERP) shall provide a field strength not less than 215 μV/m (-99 dBW/m^2) for a horizontally polarized signal. The ERP shall provide a field strength not greater than 350 mV/m (-35 dBW/ m^2) for a horizontally polarized signal. The ERP shall provide a field strength not less than 136 μV/m (-103 dBW/ m^2) for the vertically polarized signal. The ERP shall provide a field strength not greater than 221 mV/m (-39 dBW/ m^2) for the vertically polarized signal.

3.2.2.4.1 Measured Field Strength

Field strength shall be measured as an average over the period of the unique word in the training sequence portion of the message.

3.2.2.4.2 Phase Offset

The phase offset between Horizontal Polarization (HPOL) and Vertical Polarization (VPOL) signal components, defined as the RF phase angle between the arrival times of the peak VPOL E-field and the peak HPOL E-field, shall fall in the range 90° ± 40°.

3.2.2.5 Spectral Characteristics

3.2.2.5.1 Carrier Frequencies

The LGF shall operate on 25.0 kHz centers. The lowest assignable channel shall be centered at 108.000 MHz. The highest assignable channel shall be centered at 117.975 MHz. Selection of the nominal frequency shall be manually adjustable.

3.2.2.5.2 Spurious Emissions

Spurious emissions shall be in accordance with Title 47 Part 2, Code of Federal Regulations (CFR).

3.2.2.6 Adjacent Channel Emissions

The amount of power, as defined in Section 4.1.5.3 of RTCA/DO-246, during transmission under all operating conditions when measured over a 25 kHz bandwidth centered on either of the first adjacent channels shall not exceed –40 dB referenced to the on-channel power.

The power during VBD transmission when measured over a 25 kHz bandwidth centered on either of the second adjacent channels shall not exceed –65 dB referenced to the on-channel power and shall decrease 5 dB per octave until –90 dB and remain less than –90 dB thereafter.

3.2.2.6.1 Adjacent Temporal Interference

The peak power contained within the 25 kHz channel bandwidth, centered on the assigned frequency at any time outside of the assigned time slots, shall not exceed -75 dBc referenced to the on-channel power.

3.2.2.6.2 Frequency Stability

The long-term stability of the transmitter carrier frequency shall be ± 0.0002%.

3.2.2.7 Modulation

The modulation of LGF data shall be differentially encoded 8 phase shift keying (D8PSK) using a raised cosine filter with $\alpha = 0.6$. The information to be transmitted shall be differentially encoded with 3 bits per symbol (baud) transmitted as changes in phase rather than absolute phase. The data stream to be transmitted shall be divided into groups of three consecutive data bits, low bit first. Fill bits shall be padded to the end of the LGF data as needed for the final channel symbol.

A binary data stream entering a differential data encoder shall be converted into three separate binary streams X, Y, and Z, so that

a. bit 3n is X_n,

b. bit 3n+1 is Y_n, and

c. bit 3n+2 is Z_n.

The triplet at time k (X_k, Y_k, Z_k) shall be converted to a change in phase, depicted in Table 3-7, and the absolute phase ϕ_k is the accumulated series of $\Delta\phi_I$, I = 1, 2, 3 k, or

$$\phi_k = \phi_{k-1} + \Delta\phi_k. \tag{19}$$

The transmitted signal shall be

$$H(e^{j(2\pi ft + \phi(t))}) \tag{20}$$

where $H(\bullet)$ is a raised cosine filter with $\alpha = 0.6$, Section 3.2.2.7.1.

Table 3-7. Data Encoding

X_k	Y_k	Z_k	$\Delta\Phi_k$
0	0	0	$0\pi/4$
0	0	1	$1\pi/4$
0	1	1	$2\pi/4$
0	1	0	$3\pi/4$
1	1	0	$4\pi/4$
1	1	1	$5\pi/4$
1	0	1	$6\pi/4$
1	0	0	$7\pi/4$

3.2.2.7.1 <u>Pulse Shaping Filters</u>

Impulses are applied to baseband filters that have the shape of a raised cosine function with α equal to 0.6. The frequency and time response of the baseband filters shall be in accordance with

$$H(f)=\begin{cases} 1 & 0<f<\dfrac{1-\alpha}{2\mathrm{T}} \\ \dfrac{1-\sin\left(\dfrac{\pi}{2\alpha}\left(2f\mathrm{T}-1\right)\right)}{2}, & \dfrac{1-\alpha}{2\mathrm{T}}\le f\le\dfrac{1+\alpha}{2\mathrm{T}} \\ 0 & f>\dfrac{1+\alpha}{2\mathrm{T}} \end{cases} \tag{21}$$

$$h(t)=\frac{\sin\left(\dfrac{\pi t}{T}\right)\cos\dfrac{\pi\alpha t}{T}}{\dfrac{\pi t}{T}\left[1-\left(\dfrac{2\alpha t}{T}\right)^{2}\right]} \tag{22}$$

where f is the absolute value of the frequency offset from the channel center,

T is the symbol period of 1/10500 seconds (approximately 95.2 µ seconds),

t is time, and

α is 0.6.

3.2.2.7.2 Error Vector Magnitude

The peak error vector magnitude of the transmitted signal shall be less than 10% of the desired signal magnitude at the center of the symbol.

3.2.2.8 Message Encoding

Message encoding shall comply with Section 4.2 of RTCA/DO-246.

3.2.2.9 Broadcast Timing Structure Division Multiple Access

The broadcast timing structure shall comply with Section 4.3 of RTCA/DO-246. The LGF shall be capable of transmitting in any four time slots. The LGF shall broadcast a message in every frame assigned to that station.

3.2.2.10 Message Format

The message format shall comply with Section 4.4 of RTCA/DO-246.

3.2.3 Radio Frequency Broadcast Monitoring

The data broadcast transmissions shall be monitored. The transmission of the data shall cease within 0.5 seconds when any of the following conditions exist:

a. continuous disagreement for any 3 second period between the transmitted application data and the application data derived or stored by the monitoring system prior to transmission,

b. a transmitted power offset of more than 3 dB from the on-channel assigned power for 3 seconds,

c. more than 0.2% of messages in the last hour are not transmitted,

d. no transmission for 3 seconds, or

e. any transmitted data outside of the assigned TDMA time slots for 3 seconds.

Conditions 'a' – 'e' include the time to switch to redundant equipment, if available.

3.3 Operation and Maintenance

Operations and maintenance functions are provided via internal and external LGF components. These components include:

a. LSP (internal)

b. MDT (external)

c. RSP (external)

d. ATCU (external)

e. LGF Built-in-Test (BIT) (internal)

f. Recording (internal, Sections 3.3.3.1 and 3.3.3.2)

g. Recording (external, Sections 3.3.3.3 and 3.3.3.4)

Figure 3-4 provides a high-level diagram depicting the functional relationship between the LGF and Operations and Maintenance.

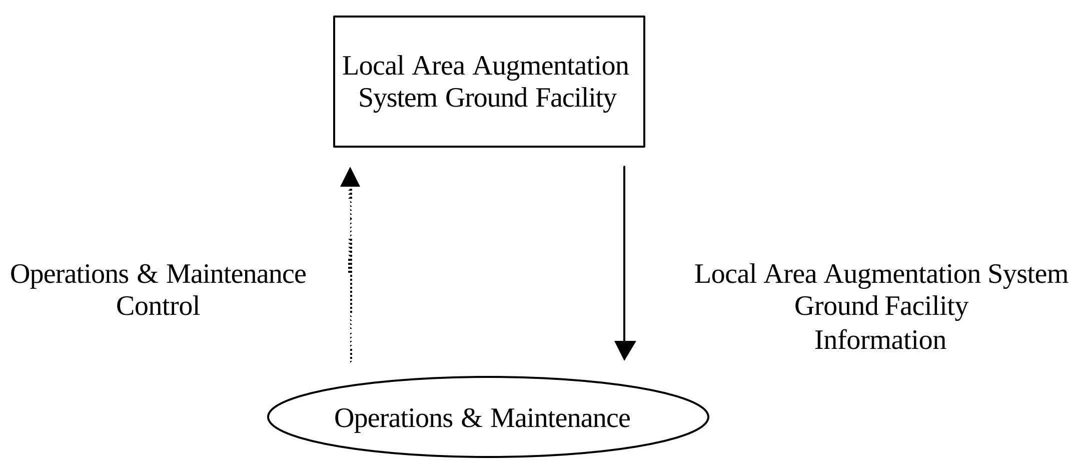


Figure 3-4. Operations and Maintenance

The internal and external interfaces of the LGF are depicted in Figure 3-5.

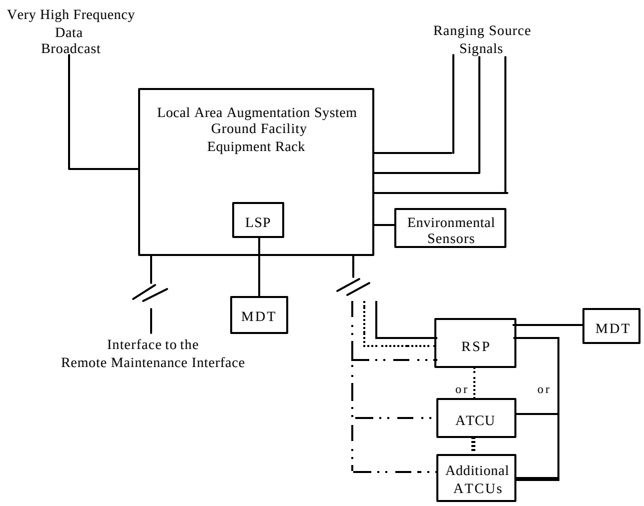


Figure 3-5. Local Area Augmentation System Ground Facility Interfaces

3.3.1 System Requirements

3.3.1.1 Environmental Design Values

Environmental design values for the LGF shall comply with the environmental conditions of Table 3-8.

3.3.1.1.1 Environmental Service Conditions

LGF equipment intended for use in attended facilities shall be designed for the ambient conditions of Environment I in Table 3-8. LGF equipment intended for use in unmanned facilities shall be designed for the ambient conditions of Environment II listed in Table 3-8. LGF equipment not housed in shelters shall be designed for the ambient conditions of Environment III listed in Table 3-8.

Table 3-8. Environmental Conditions

Environment[1]	Temperature (°C)	Relative Humidity[3] (%)	Altitude (ft above sea level)	Wind (mph)	Ice Loading	Rain
I	+10 to +50	10 to 80	0 to 10,000	--	--	--
II	0 to +50	5 to 90	0 to 10,000	--	--	--
III[4]	-50 to +70[2]	5 to 100	0 to 10,000	0 to 100	Encased in ½ radial thickness clear ice	25 mm / hour

1. I For equipment installed in an attended facility.
   II For equipment installed in an unattended facility.
   III For equipment installed outdoors (antennas, field detectors)
2. Includes 18°C for solar radiation.
3. Above 40°C, the relative humidity shall be based upon a dew point of 40°C.
4. Conformal coating is required only when equipment is exposed to salt atmosphere or located in tropical climates.

3.3.1.1.2 Wind and Ice Loading

Wind and ice loading values for LGF externally exposed equipment shall comply with Section 3.2.1.2.3 of FAA-G-2100F.

3.3.1.1.3 Non-Operating Conditions

Shipped, stored, and transported equipment for the LGF shall comply with Section 3.2.1.2.4 of FAA-G-2100F.

3.3.1.2 Primary Power

The LGF shall operate from a nominal 120 volt, 60 Hz, three wire, single phase AC power source.

3.3.1.3 Supplementary Power

The LGF shall include an uninterruptible supplementary power source. The supplementary power source shall continuously power the LGF for a period of not less than four hours after a loss of primary power.

3.3.1.3.1 Power Supply

The LGF shall automatically sense when the supplementary power discharge point is reached. When operating on supplementary power, the LGF shall initiate facility shutdown if a critical discharge point is met. The LGF shall have the capability to self restore to operate on primary power upon restoration of primary power. To maintain the supplementary power in operational readiness, a trickle charge shall be supplied to recharge the supplementary power during the period of available primary power. Upon loss and subsequent restoration of primary power, the LGF supplementary power shall restore to a full charge condition from a 50% discharge condition within 8 hours. The LGF shall continue at the same level of service upon restoration of primary power.

3.3.1.4 Environmental Sensors

The LGF design shall include an

a. intrusion detector sensor,
b. smoke detector sensor,
c. obstruction lights sensor,
d. AC power sensor,
e. inside temperature sensor, and
f. outside temperature sensor.

The environmental sensor output shall be processed by the LGF and retrievable by the MDT. The LGF shall be capable of bypassing any sensor that is not utilized.

3.3.1.4.1 Intrusion Detector

The intrusion detector shall detect when the LGF shelter door has been opened for any period greater than 0.50 seconds. The LGF shall generate an alert message if valid log-on ID and password entries are not received within 5 minutes of detecting an open shelter door. The LGF shall provide the capability to arm and bypass the intrusion detector through the MDT.

3.3.1.4.2 Smoke Detector

The smoke detector shall be an ionization-type smoke detector. The smoke detector shall meet the requirements of Underwriters Laboratories (UL), Inc. Standard 268. The smoke detector shall bear the UL, Inc. label. The LGF shall generate a service alert upon detection of combustion products.

3.3.1.4.3 Obstruction Lights

The LGF shall identify when a lamp has failed in the obstruction light assembly of the antennas. The LGF shall generate an alert message when a lamp fails.

3.3.1.4.4 Alternating Current Power

The AC power sensor shall detect the presence of primary AC power. The AC power sensor shall detect absence of primary AC power. The LGF shall generate a service alert when a loss of AC power is detected.

3.3.1.4.5 Inside Temperature

The inside temperature sensor shall provide the temperature inside the LGF equipment shelter to the LGF, with a minimum resolution of one-degree centigrade. The accuracy over the range of -10º to +50º centigrade shall be ± 4º centigrade without calibration. The LGF shall generate a service alert message when the upper and lower temperature limits are exceeded.

3.3.1.4.6 Outside Temperature

The outside temperature sensor shall provide the temperature outside the LGF equipment shelter to the LGF with a minimum resolution of no less than one-degree centigrade. The accuracy over the range of -50° to +70° centigrade shall be ± 4° centigrade without calibration.

3.3.1.5 Fault Diagnostics, Built-in-Test, and Isolation Procedures

The LGF shall include the capability to perform automatic and manually-initiated fault diagnosis to the LRU level. The resulting data shall be stored in memory until manually cleared via the MDT. Stored data shall be accessible via the MDT. Manually initiated diagnostics shall be available from the MDT. A combination of fault diagnostics, BIT, and manual isolation shall provide for the following actions:

a. automatically initiating the diagnostic routine when an alarm occurs,

b. automatic diagnostic fault isolation rates at 90% or greater to an ambiguity group of three LRUs or less, and

c. manual isolation to a single LRU 100% of the time.

3.3.1.6 Maintainability of Electronic Equipment

3.3.1.6.1 Maintenance Concept

The LGF shall provide for a site and depot concept of maintenance. This concept assumes the use of modular equipment that enables maintenance specialists to correct a majority of equipment failures on-site by replacing the faulty LRU.

3.3.1.6.2 Unscheduled Maintenance

3.3.1.6.2.1 Reliability

The mean time between unscheduled maintenance actions for the LGF shall be at least 2190 hours. The mean time between unscheduled maintenance actions for the ATCU shall be a minimum of 40,000 hours. Unscheduled maintenance actions are those actions required to correct an alarm or service alert condition. These actions exclude environmental service alerts.

3.3.1.6.2.2 Maintainability

The Mean-Time-to-Repair (MTTR) shall be less than 30 minutes. The repair time shall include

a. diagnostic time,

b. removal of the failed LRU,

c. installation of the new LRU,

d. initialization of the new LRU, and

e. all adjustments required to return the LGF to Normal Mode.

Any maintenance action that requires the replacement of a failed LRU and does not require a re-certifying flight check can be replaced while the LGF is in Normal Mode.

3.3.1.6.3 Periodic Maintenance

Periodic maintenance for the LGF shall not interrupt service for more than eight hours per year of operation. No single group of periodic procedures shall be required more frequently than every 2190 hours. Periodic maintenance for the RSP shall not exceed one hour in 4380 hours of operation. Periodic maintenance for the ATCU shall not exceed one hour in 4380 hours of operation. Periodic maintenance shall include the time required to complete the routine checks and inspections necessary to assure normal operation.

The capability to isolate latent faults affecting integrity and continuity shall be provided through the MDT. Isolation of latent failures shall be provided through either embedded equipment, software, or with special test equipment.

3.3.1.6.4 System Specialist Workload

Completion of corrective and periodic maintenance actions shall require no more than two system specialists.

3.3.1.7 Security

The internal and external LGF components shall provide for protection of internally stored information and information transfer in accordance with FAA Order 1370.82.

3.3.1.7.1 System Identifiers and Authenticators

The internal and external components of the LGF shall provide restrictive access via log-on implementation. Security authentication shall ensure only authorized personnel can log-on successfully. LGF displays shall display a warning banner approved by the Office of the Chief Information Officer (CIO) and the Officer of the Chief Counsel (AGC) to each user before login.

3.3.1.7.1.1 Security Levels

All information pertaining to the LGF has been assigned a minimum security level of Commercial Security (CS) 2 in accordance with FAA Order 1370.82.

3.3.1.7.1.2 Read Access

The capability to view LGF internally stored data and diagnostic information shall be provided at the RSP and LSP interface with an MDT. Provisions for read access at the RMI port shall be provided.

Note: The RMI capability is expected to be utilized at a later date, yet to be determined.

3.3.1.7.1.3 Write Access

The capability to load FAS data, input site specific parameters, and all other maintenance actions shall be provided at the LSP and RSP with an MDT in accordance to Sections 3.3.1.7.1.3.1 and 3.3.1.7.1.3.2.

3.3.1.7.1.3.1 Write Access – Local Status Panel

Write access shall be provided at the LSP for Test Mode, Normal Mode, and Not Available Mode.

3.3.1.7.1.3.2 Write Access – Remote Status Panel

Write access shall be provided at the RSP for Normal Mode and Not Available Mode.

3.3.1.7.2 User Identifications and Passwords

User IDs and passwords for the LGF shall accommodate a minimum combination of six alphanumeric characters and a maximum combination of eight alphanumeric characters. The LGF shall accommodate 24 user ID and password combinations. The ability to add, delete, and modify user IDs and passwords shall be preceded by a password confirmation prompt. User IDs shall be visible to the log-on terminal. User ID and password lists shall be immediately and automatically updated to reflect changes entered at an MDT.

3.3.1.7.2.1 Logical Access Control

Logical access to files and objects shall be restricted via password and user IDs. Logical access levels shall include the following:

a. Access Level 1: Read Only – General Use

b. Access Level 2: Read/Write – Certified Maintenance Specialist

c. Access Level 3: Administrative – Restricted

3.3.1.7.3 Invalid User Identification or Password Entry

An invalid logon entry attempt shall cause

a. an error message indicating "Invalid User ID or Password" to be output to the MDT,

b. the access procedure to be terminated after three consecutive invalid entries,

c. the LGF logon process to return to idle, and

d. a user to be inhibited from access for a period of 15 minutes after three invalid entries.

3.3.1.7.4 Log-on Time-out

The LGF shall provide a time-out that requires the log-on procedure to be repeated if the interface is idle for more than 15 minutes. Any valid message transmitted over the interface shall re-initiate the timeout.

3.3.1.8 Physical Design and Packaging

The LGF and the status and control subsystem component equipment shall be designed and packaged as to facilitate the accomplishment of all testing, adjustments, and maintenance procedures.

3.3.1.9 Electrical

3.3.1.9.1 Electrical Wiring

Electrical wiring shall comply with Section 3.1.2.1 of FAA-G-2100F.

3.3.1.9.1.1 External Wiring

External wiring to equipment that interfaces with the power source shall be in accordance with the National Electrical Code (NFPA 70), FAA-STD-032, and FAA-C-1217.

3.3.1.9.2 Alternating Current Line Controls

Each control switch, relay, circuit breaker, fuse, or other device that acts to disconnect the AC supply line energizing the LGF equipment shall be in accordance with NFPA 70 or UL 1950 for Information Technology Equipment.

3.3.1.9.3 Main Power Switch

The LGF shall have a front panel mounted, main power switch labeled "On/Off". Main power termination shall include supplementary power termination. Switches or circuit breakers that function as main power switches shall comply with Section 3.1.2.2.2 of FAA-G-2100F.

3.3.1.9.4 Alternating Current Line-Input Resistance to Ground

Each individual chassis unit connected to the AC supply line shall comply with Section 3.1.2.2.3 of FAA-G-2100F.

3.3.1.9.5 Alternating Current Line Connectors and Power Cord

Plugs, receptacles, and power cords provided for connecting the equipment to the AC supply line shall meet the requirements of NFPA 7O and be in accordance with Section 3.1.2.2.4 of FAA-G-2100F.

3.3.1.9.6 Alternating Current Line Controls

Each equipment unit energized by direct connection to the AC line shall comply with Section 3.1.2.2.5 of FAA-G-2100F.

3.3.1.9.7 Transformer Isolation, Direct Current Power Supplies

All non-switching Direct Current (DC) power supplies energized from the AC line power source shall be in accordance with Section 3.1.2.2.6 of FAA-G-2100F.

3.3.1.9.8 Voltage Regulators

External voltage regulating transformers shall not be used. Voltage regulation in the equipment shall be provided by voltage or current regulators, or both, in the DC output circuit of the power supplies.

3.3.1.9.9 Convenience Outlets

Convenience outlets provided on the equipment cabinets shall be in accordance with Section 3.1.2.2.7 of FAA-G-2100F.

Note: Only the minimum number of convenience outlets necessary for maintenance should be provided.

3.3.1.9.10 Circuit Protection

All equipment power output circuits shall be designed to include circuit protection in accordance with Section 3.1.2.3 of FAA-G-2100F.

3.3.1.9.11 Electrical Overload Protection

3.3.1.9.11.1 Current Overload Protection

Current overload protection for equipment shall be in accordance with Section 3.1.2.4.4.1 of FAA-G-2100F.

3.3.1.9.11.2 Protective Devices

Protective devices for wired-in equipment shall be in accordance with Section 3.1.2.4.4.2 of FAA-G-2100F.

3.3.1.9.12 Circuit Breakers

Circuit breakers shall be in accordance with Section 3.1.2.4.4.3 of FAA-G-2100F.

3.3.1.9.12.1 Short Circuit Coordination

Short circuit coordination shall comply with Section 3.1.2.4.4.3.1 of FAA-G-2100F.

3.3.1.9.12.2 Normal Performance

The use of overload or other protective devices shall comply with Section 3.1.2.4.4.4 of FAA-G-2100F.

3.3.1.9.13 Test Points and Test Equipment

Functional checks and trouble shooting of the LGF shall be possible through the provision of test points that are readily accessible.

3.3.1.9.13.1 Built-in-Test Device Requirements

BIT devices shall comply with Section 3.1.2.5.1 of FAA-G-2100F.

3.3.1.9.13.2 Location of Test Points and Adjustment Controls

Location of test points and adjustment controls shall comply with Section 3.1.2.5.3 of FAA-G-2100F.

3.3.1.9.13.3 Test Point Circuitry Protection

Test point circuitry protection shall comply with Section 3.1.2.5.4 of FAA-G-2100F.

3.3.1.9.13.4 Failure

BIT devices shall comply with Section 3.1.2.5.5 of FAA-G-2100F.

3.3.1.9.14 Electrical Breakdown Prevention

Preventative measures for electrical breakdown shall be in accordance with Section 3.1.2.6.2 of FAA-G-2100F.

3.3.1.9.15 Grounding, Bonding, Shielding, and Transient Protection

Grounding, bonding, shielding, and transient protection for the LGF shall be in accordance with FAA-STD-020 for Non-Developmental Items (NDI) and developmental items. At the facility interface, the requirements for grounding, bonding, shielding, and transient protection shall be in accordance with NFPA 70 and shall not violate the requirements of FAA-STD-020. If the item is to be UL-recognized, protective measure shall be in accordance with UL 1950 for Information Technology Equipment.

3.3.1.9.16 Obstruction Lights

A double obstruction light assembly shall be provided, where required, in accordance with FAA AC 150/5345-43E and FAA AC 70/7460-1J. The lamps shall be wired in parallel. The lamps shall be rated at 100 watts each.

3.3.1.9.17 Power Factor

The power factor shall comply with the requirements in Section 9.J(4) of FAA Order 6950.2D.

3.3.1.9.18 Peak Inrush Current

Peak inrush current and total current harmonic distortion shall meet the requirements of Section 3.1.2.4.3 of FAA-G-2100F and Sections 9.J(3) and 9.J(5) for FAA Order 6950.2D.

3.3.1.10 Markings

Markings shall be permanent and legible.

3.3.1.10.1 Radio Frequency Connectors

Markings for RF connectors shall comply with Section 3.3.3.2.2.1 of FAA-G-2100F.

3.3.1.10.2 Fuse Markings

Markings for fuse positions shall comply with Section 3.3.3.2.2.4 of FAA-G-2100F.

3.3.1.10.3 Terminal Strips and Blocks

Markings for terminal strips and blocks shall comply with Section 3.3.3.2.2.5 of FAA-G-2100F.

3.3.1.10.4 Controls and Indicating Devices

Markings for controls and indicating devices shall comply with Section 3.3.3.2.2.7 of FAA-G-2100F.

3.3.1.10.5 Nameplates

Furnished equipment shall have one or more nameplates as determined by the equipment configuration in accordance with Figure IV of FAA-G-2100F.

3.3.1.10.6 Safety Related Markings

Guards, barriers or access doors, covers, and plates shall be marked to indicate the hazard that may be reached upon removal of such devices. When possible, marking shall be located such that it is not removed when the barrier or access door is removed. Warnings of hazards internal to a unit shall be marked adjacent to hazards if they are significantly different from those of surrounding items. Such a case would be a high voltage terminal in a group of low voltage devices.

3.3.1.10.6.1 Physical Hazards

Physical hazards shall be marked with color codes in accordance with American National Standards Institute (ANSI) Z535.l where applicable to electronic equipment.

3.3.1.10.6.2 Center-of-Gravity

Center-of-Gravity shall be marked on all equipment with a center-of-gravity 50% different from the Center-of-Volume of the chassis.

3.3.1.10.7 Accident Prevention Signs and Labels

Accident prevention signs and labels shall be in accordance with Section 3.3.6.5.2 of FAA-G-2100F.

3.3.1.10.8 Sign Design

Sign design shall be in accordance with Section 3.3.6.5.2.1 of FAA-G-2100F.

3.3.1.10.9 Sign Classification and Detailed Design

3.3.1.10.9.1 Class I - Danger Classification

Signs indicating immediate and grave danger or peril, a hazard capable of producing irreversible damage or injury, and prohibitions against harmful activities shall be in accordance with Section 3.3.6.5.2.2.1 of FAA-G-2100F.

3.3.1.10.9.2 Class II - Caution Classification

Signs used to call attention to potential danger or hazard, or a hazard capable of or resulting in severe but not irreversible injury or damage shall be in accordance with Section 3.3.6.5.2.2.2 of FAA-G-2100F.

3.3.1.10.9.3 Class III - General Safety Classification

Signs of general practice and rules relating to health, first aid, housekeeping, and general safety shall be in accordance with Section 3.3.6.5.2.2.3 of FAA-G-2100F.

3.3.1.10.9.4 Class IV - Fire and Emergency Classification

Signs used to label and point the way to fire extinguishing equipment, shutoffs, emergency switches, and emergency procedures shall be in accordance with Section 3.3.6.5.2.2.4 of FAA-G-2100F.

3.3.1.11 Personnel Safety and Health

The design and development of electronic equipment shall provide for the safety of personnel during the installation, operation, maintenance, repair, and interchange of complete equipment assemblies or component parts. Equipment design for personnel safety shall be equal to or better than the requirements of the Occupational Safety and Health Act (OSHA) as identified in CFR Title 29, Part 1910.

3.3.1.11.1 <u>Human Factors Engineering</u>

When establishing general and detailed design criteria, elements affecting safety shall be human factors engineered. The designs shall eliminate or mitigate hazards associated with

a. hazardous components,

b. safety-related interface considerations between the equipment and other portions of the system,

c. environmental constraints including the operating environment,

d. operating, test, maintenance, and emergency procedures,

e. facilities and support equipment, and

f. safety related equipment, safeguards, and possible alternate approaches.

3.3.1.11.2 <u>Electrical Safety</u>

Personnel shall be protected with respect to electrical contact in accordance with Section 3.3.6.1 of FAA-G-2100F.

3.3.1.11.2.1 <u>Ground Potential</u>

Grounding of external parts, surfaces, and shields shall be in accordance with Section 3.3.6.1.1 of FAA-G-2100F.

3.3.1.11.2.2 <u>Hinged or Slide Mounted Panels and Doors</u>

Hinged or slide mounted panels and doors shall be grounded in accordance with Section 3.3.6.1.2 of FAA-G-2100F.

3.3.1.11.2.3 <u>Shielding</u>

Shielding on wire and cable shall be grounded in accordance with Section 3.3.6.1.3 of FAA-G-2100F except when a conflict with the grounding requirements of Section 3.3.1.9.15 would be created.

3.3.1.11.2.4 <u>Radio Frequency Voltage Protection</u>

Personnel shall be protected from accidental contact with transmitter output terminals, antennas, and devices that carry sufficient RF voltage to cause injury.

3.3.1.11.2.5 <u>Electrical Connectors</u>

Electrical connectors shall comply with Section 3.3.6.1.12 of FAA-G-2100F.

3.3.1.11.3 Radio Frequency Limits

3.3.1.11.3.1 Applicability of Federal Standards

Equipment design for which a federal standard exists under the CFR Title 21, Chapter I, Subchapter J shall conform to the appropriate federal standard.

3.3.1.11.3.2 Radiation Hazards and Protection

All electronic equipment or electrical devices capable of emitting x-radiation or RF/microwave radiation between 300 kHz and 100 GHz shall be designed, fabricated, shielded, and operated to the requirements of FAA Order 3910.3A.

3.3.1.11.4 Cathode Ray Tubes

Cathode ray tubes shall conform to the requirements of UL Standard 1418, where applicable.

3.3.1.12 Hazardous and Restricted Materials

Assessment of the hazard potential of a substance and its decomposition products shall be performed before material selection. This assessment shall include those materials listed in Section 3.3.6.6 of FAA-G-2100F.

3.3.1.13 Federal Communications Commission Type Acceptance and Registration

The first production equipment shall be subjected to the Federal Communication Commission (FCC) type acceptance and registration procedures in accordance with the FCC Rules and Regulations of the CFR, Title 47, Part 2, Part 68, and Part 87. The environmental temperature range specified by the FCC shall supersede, for the purposes of the FCC Type Acceptance Procedures, the service condition temperature range that is applicable under the equipment specification and this specification. Compliance with FCC Regulations shall be maintained with regards to any approved changes made to the production equipment that is relevant to the FCC Type Acceptance or Registration.

3.3.2 Control and Display

All control and display units shall be designed in accordance with Human Factors guidelines, defined in Section 3.3.7 of FAA-G-2100F.

3.3.2.1 Local Status Panel

An LSP shall be provided as the on-site maintenance interface to the LGF. The LSP shall provide two, nine pin female connectors for any maintenance interfaces to the LGF, including the MDT.

3.3.2.1.1 Local Status Panel – Modes and Service Alerts

The LSP shall annunciate

a. Green for Normal,

b. Red for Not Available,

c. Yellow for Test, and

d. Orange for Service Alert.

The LSP shall display a change in mode and service alerts within 3 seconds of detection by the LGF.

3.3.2.1.1.1 Local Status Panel – Initialization

The LSP shall simultaneously annunciate green, red, yellow, and orange during a power up, manual reset, or automatic restart.

3.3.2.1.2 Local Status Panel – Aural Signal

The LSP shall initiate a steady tone aural signal when the LGF is Not Available. The LSP shall initiate an intermittent beep aural signal when there is a service alert.

3.3.2.1.3 Local Status Panel – Mute Switch

The LSP shall provide the capability to manually silence an aural signal.

3.3.2.2 Remote Status Panel

An RSP shall be provided as an external interface, located within 50 miles of the airport. The RSP shall provide two, nine pin female connectors for any maintenance interface (Section 3.3.4.3) to the LGF, including the MDT.

3.3.2.2.1 Remote Status Panel – Modes and Service Alerts

The RSP shall annunciate

a. Green for Normal,

b. Red for Not Available,

c. Yellow for Test, and

d. Orange for Service Alert.

The RSP shall display a change in mode and service alerts within 3 seconds of detection by the LGF.

3.3.2.2.1.1 Remote Staus Panel – Initialization

The RSP shall simultaneously annunciate green, red, yellow, and orange during a power up, manual reset, or automatic restart.

3.3.2.2.2 Remote Status Panel – Aural Signal

The RSP shall initiate a steady tone aural signal when the LGF is Not Available. The RSP shall initiate an intermittent beep aural signal when there is a service alert.

3.3.2.2.3 Remote Status Panel – Mute Switch

The RSP shall provide the capability to manually silence an aural signal.

3.3.2.2.4 Remote Status Panel – Supplementary Power

The RSP shall include the capability to remain continuously powered for at least two hours of uninterrupted operation via a supplementary power source after the loss of primary AC power. Restoration of primary power shall not negatively effect the operation of the respective subsystems.

3.3.2.3 Maintenance Data Terminal

An MDT shall be provided, interfacing to the LGF through the LSP and RSP, to a distance of 20 ft. The MDT shall follow the security requirements of Section 3.3.1.7. All manually entered data shall be stored in LGF NVM. The MDT shall be provided with a 3 ½ floppy disk drive. A computer virus check for malicious code shall be performed on any data to be transferred to the LGF via the MDT. Malicious code is defined as an unauthorized attempt to include software or firmware that is capable of corrupting the operation of the LGF.

3.3.2.3.1 Maintenance Data Terminal Control and Display

The MDT shall provide the capability to command and monitor all test and maintenance actions available through the interface.

3.3.2.3.1.1 Restart

The MDT shall provide the capability to restart the LGF. Commanding restart shall cause all program variables and all software and firmware controlled hardware to be initialized to a predefined condition from which normal program execution can continue.

3.3.2.3.2 States and Modes Display

The MDT shall provide the capability to display the current LGF state and mode, defined in Section 3.1.4.

3.3.2.3.3 Alerts and Alarm Display

The MDT shall provide the capability to display, within 3 seconds, all alert and alarm messages generated by the LGF.

3.3.2.3.4 Very High Frequency Data Broadcast Display

The MDT shall display the VDB status as either transmitting or not transmitting. The MDT shall provide the capability to display the VDB message type and data fields.

3.3.2.3.5 Very High Frequency Data Broadcast Control

The MDT shall provide the capability to activate and deactivate the VDB. VDB deactivate shall by-pass the VDB antenna and terminate into a dummy load.

3.3.2.3.6 Very High Frequency Data Broadcast Message Data

The MDT shall provide the capability to input the following VDB message data for each message type and parameter:

a. Message Header
    1. Reference Station ID
b. Type 1 Message
    1. Measurement Type
c. Type 2 Message
    1. LGF Installed RRs
    2. LGF Accuracy Designator
    3. Local Magnetic Variation
    4. Refractivity Index
    5. Scale Height
    6. Refractivity Uncertainty
    7. Latitude
    8. Longitude
    9. Vertical Ellipsoid Offset
d. Type 4 Message
    1. Data Set Length
    2. FAS Data Block - manually entered as a block in its entirety:
        a) Operation Type
        b) SBAS Provider Identification

c) Airport Identification

d) Runway Number

e) Runway Letter

f) Approach Performance Designator

g) Route Indicator

h) Reference Path Data Selector

i) Reference Path Identifier

j) LTP/FTP Latitude

k) LTP/FTP Longitude

l) LTP/FTP Height

m) Δ FPAP Latitude

n) Δ FPAP Longitude

o) Approach TCH Height

p) Approach TCH Unit Selector

q) GPA

r) Course Width

s) Δ Length Offset

t) FAS CRC

3. FAS VAL/Approach Status – Lateral Navigation (LNAV) Only

4. FAS LAL/Approach Status – Approach Not Available

3.3.2.3.7 System Power Display

The MDT shall provide the capability to display the LGF power source.

3.3.2.3.8 Alerts and Alarm Status Display

The MDT shall provide the capability to display the status of all existing alerts and alarms.

3.3.2.3.9 Alerts and Alarm Threshold Display

The MDT shall provide the capability to display the thresholds and tolerances for alert, service alert, constellation alert, and alarm parameters, as defined in Sections 3.1.5.1.2, 3.1.5.1.3, 3.1.5.1.4, and 3.1.5.1.5.

3.3.2.3.10 Alerts and Alarm Threshold Control

The MDT shall provide the capability to modify the thresholds for alert, service alert, constellation alert, and alarm parameters, as defined in Sections 3.1.5.1.2, 3.1.5.1.3, 3.1.5.1.4, and 3.1.5.1.5. The ability to change a parameter setting in minimum steps consistent with individual parameter tolerances shall be provided. The ability to manually enter a parameter setting within design tolerances shall be provided.

3.3.2.3.11 Monitor By-pass

3.3.2.3.11.1 By-Pass Annunciation

The MDT shall provide the capability to by-pass the aural annunciation of all alerts and alarms to the LSP, RSP, or ATCU, or all simultaneously while the LGF is in the Test Mode. The MDT by-pass annunciation function shall provide a configurable default setting.

3.3.2.3.11.2 By-Pass Actions

The MDT shall provide the capability to by-pass any actions identified in Tables 3-1 and 3-2.

3.3.2.3.12 Static Site Data Display

The MDT shall provide the capability to display the following site-specific parameters:

a. VDB Frequency,
b. VDB Power,
c. TDMA Time Slot(s),
d. RR Geodetic Coordinates, and
e. Reception Mask

3.3.2.3.13 Static Site Data Control

The MDT shall provide the capability to control input for the following site-specific parameters:

a. VDB Frequency, 108.000 MHz to 117.975 MHz in 25 kHz channels,
b. VDB Power Adjustment,
c. TDMA Time Slot(s),
d. RR Geodetic Coordinates (WGS-84), and
e. Reception Mask.

3.3.2.3.14 Approach Status Display

The MDT shall simultaneously display the approach status for up to 16 runway ends. The MDT shall display the enable, disable, and Lateral Navigation (LNAV) status of each runway end supported by the LGF.

3.3.2.3.15 Approach Control

The MDT shall include the capability to simultaneously enable all approaches associated with each runway end served by the LGF. The MDT shall include the capability to simultaneously disable all approaches associated with each runway end served by the LGF. This capability will enable or disable all approaches to a runway end with a single action.

3.3.2.3.16 Redundant Equipment Status Display

The MDT shall provide the capability to display the status for both classifications of LGF equipment, Main and Standby. Main and Standby equipment and the possible status shall be:

a. Main – Primary LGF Equipment
   1. On-line – Primary LGF equipment is on-line and operational.
   2. Failed – Equipment has failed and is not available for operational use.
   3. Disabled – Equipment has been disabled.

b. Standby – Backup/redundant LGF Equipment
   1. Available – Equipment is functional and is available for switchover following a main equipment failure.
   2. Failed – Equipment has failed and is not available for operational use.
   3. Disabled – Equipment has been disabled.
   4. On-line – Backup/redundant LGF equipment in on-line and operational.

3.3.2.3.17 Redundant Equipment Control

The MDT shall provide the capability to change the classification of the LGF equipment as indicated in Section 3.3.2.3.16.

3.3.2.3.18 Diagnostics Display

The MDT shall provide the capability to display diagnostic results following a failure or a manual initiation. On-screen help shall be provided in order to perform diagnostics and other maintenance related actions.

3.3.2.3.19 Diagnostics Control

The MDT shall provide the capability to manually initiate diagnostics. Manually initiated diagnostics shall include

a. Non-intrusive - Non-intrusive diagnostics do not affect the current LGF operation.

b. Intrusive - Intrusive diagnostics may affect the LGF operation or require a re-certification Flight Check.

3.3.2.3.20 Temperature Display

The MDT shall provide the capability to display the temperature inside and outside of the LGF equipment facility.

3.3.2.3.21 Adjustment Storage

Before log-off, MDT-entered settings and adjustment shall be confirmed and the values stored in LGF NVM.

3.3.2.4 Remote Maintenance Interface

The RMI shall be capable of providing all display features identical to an MDT. An RMI port shall be provided at the LSP and RSP.

3.3.2.5 Air Traffic Control Unit

A primary ATCU shall be provided as an external interface for installation in control towers and terminal and en route radar facilities at locations up to 50 miles from the airport. The ATCU shall be capable of working with up to 10 integrated ATCUs that are located between 15 feet and 5 miles of the primary ATCU.

3.3.2.5.1 Air Traffic Control Unit - Approach Control

The ATCU shall include the capability to simultaneously enable all approaches associated with each runway end served by the LGF. The ATCU shall include the capability to simultaneously disable all approaches associated with each runway end served by the LGF. This capability will enable or disable all approaches to a runway end with a single action.

3.3.2.5.2 Air Traffic Control Unit – Operational Status Display

The ATCU shall simultaneously display the operational status for up to 16 runway ends. This shall include notice that the runway end is either enabled, disabled, or LNAV Only. "LNAV Only" shall be displayed when the vertical guidance for a runway end is disabled.

3.3.2.5.3 Air Traffic Control Unit - Modes

The ATCU shall display "Category 1," corresponding to the Normal Mode defined in Section 3.1.4.3. The ATCU shall display "Not Available," corresponding to the Not Available Mode defined in Section 3.1.4.4 or when in the Off State. The ATCU shall display changes in modes within 3 seconds of detection by the LGF.

3.3.2.5.4 Air Traffic Control Unit - Maintenance Display

When the LGF is in the Test Mode, the ATCU shall simultaneously display "Test" and "Not Available." No other display lights shall be illuminated.

3.3.2.5.5 Air Traffic Control Unit Constellation Alert Display

The ATCU shall display a constellation alert within 3 seconds from the time of prediction. The ATCU shall display the start time and the end time of the predicted outage.

3.3.2.5.6 Aural Signal

The ATCU shall initiate an aural signal for all LGF mode changes. The ATCU shall initiate an aural signal for all constellation alerts.

3.3.2.5.6.1 Audio Control

The ATCU shall provide the capability to manually control an aural signal with a range from low but not silenced to audible over ambient noise levels. The ATCU shall provide for a switch that acknowledges and silences the aural signal until reset or another event occurs.

3.3.2.5.7 Design Requirements

The ATCU design shall provide for transfer and lockout control between the primary ATCU and the integrated ATCUs. The ATCU shall be configurable to lock out control functions and provide status display only. The ATCU shall provide visual and aural annunciation for changes and updates of LGF status information.

3.3.2.5.7.1 Monitor Design Requirements

The ATCU monitor shall be designed to the following requirements:

a. Configurable for the following physical environments, including:
   1. rack mounted in standard 19" equipment racks,
   2. flush mounted into the control tower console, Terminal Radar Approach CONtrol (TRACON), and Air Route Traffic Control Center (ARTCC), and
   3. setup as an independent workstation.

b. Display screen attributes:
   1. 14" color flat screen LCD,
   2. a resolution of at least 800 x 600 pixels and 72 Dots Per Inch (dpi),
   3. refresh rate of more than 70 Hz,
   4. viewing angle at least 160° in vertical and horizontal planes,
   5. equipped with a touch screen input,
   6. visible under all control tower lighting conditions, including direct sunlight and night operations,
   7. luminescence rating ranging from ≥ 40 nits to ≤ 900 nits, and

8. anti-glare treatment that does not reduce available light to less than 800 nits at the highest brightness setting.

c. External components and controls, including

1. speaker,
2. volume control, and
3. brightness control.

The luminescence rating for the ATCU monitor shall be verified under actual operating conditions.

The ATCU monitor shall default to a standard resolution of not less than 800 x 600 pixels in the event of a power failure. The ATCU monitor shall store the last used resolution internally. The ATCU monitor shall store configuration and calibration settings for resolution when the LGF performs a cold boot.

3.3.3 Recording

Filtering of repetitive events shall be permitted, with the most recent event logged with an indication of the start of the event. Commands to write over or delete any of the data sets in Sections 3.3.3.1, 3.3.3.2, 3.3.3.3, and 3.3.3.4 shall not be permitted. The LGF NVM used to store data shall be secure at all times from tampering and manipulation.

3.3.3.1 System Events

The LGF shall maintain a chronological record in NVM of the previous 90 days of date, time, inside and outside temperature, log-on, log-off, alert, service alert, constellation alert, and alarm events. The capability to display system events records shall be provided via an MDT.

3.3.3.2 Events Recording

The LGF shall utilize the data from the sigma monitor, Section 3.2.1.2.7.7.1, to provide an indication of the hourly, daily, monthly, and yearly characteristics of the error in the broadcast correction. The data shall be recorded in NVM and exportable to the MDT and displayed on control chart(s) that includes alerts, service alerts, alarms, and action lines.

3.3.3.3 Very High Frequency Data Broadcast Recording

The LGF shall automatically record all data broadcast parameters for a period not less than 48 hours. This data shall be exportable via a standard, commercially available electronic media. One 48-hour block of data shall be stored in NVM concurrently while the current 48-hour block of data are being recorded. At the end of each 48-hour period, the data stored from the previous 48 hours can be deleted and replaced with the current block of data. Upon command from the MDT, the recording function shall be terminated for a period not to exceed 30 minutes. Four time windows for one, 24-hour period shall be selectable to capture any requested VDB field(s).

This shall be programmable for up to one week prior, and shall not interfere with the other recording requirement.

3.3.3.4 Reference Receiver Data

The LGF shall automatically record RR data for all RRs for a period not less than 48 hours. This data shall be exportable via a standard, commercially available electronic media. One 48-hour block of data shall be stored in NVM concurrently while the current 48-hour block of data are being recorded. At the end of each 48-hour period, the data stored from the previous 48 hours can be deleted and replaced with the current block of data. Recorded RR data shall include at a minimum,

a. L1 carrier phase with a resolution of 0.01 cycles,

b. L1 C/A code pseudorange with a resolution of .01 meter or better, and

c. broadcast navigation data for all tracked GPS ranging sources.

Upon command from the MDT, the recording function shall be terminated for a period not to exceed 30 minutes.

3.3.4 Interface Requirements

3.3.4.1 Local Status Panel Interface

The vendor shall define all LSP interface requirements. The interface characteristics shall be commercially available and in accordance with International Standards Organization (ISO) standards and recommendations.

3.3.4.2 Remote Status Panel Interface

The vendor shall define all RSP interface requirements. The interface characteristics shall be commercially available and in accordance with ISO standards and recommendations.

3.3.4.3 Maintenance Data Terminal Interface

The MDT interface shall conform to EIA/TIA-232-E, Interface Between Data Terminal Equipment and Data Communications Equipment Employing Serial Binary Data Interchange (Electronic Industries Association, July 1991).

3.3.4.4 Air Traffic Control Unit Interface

The vendor shall define all ATCU and integrated ATCU interface requirements. The interface characteristics shall be commercially available and in accordance with ISO standards and recommendations.

4. Verification

4.1 Test Program

The testing and test activities of inspection, analysis, and demonstration assure that LGF hardware, software, and system requirements have been fully satisfied in accordance with the Acquisition Management System Test & Evaluation Process Guidelines (FAA, July 1997). These guidelines minimize reliance on explicit policies defining the conduct of test and evaluation. Practical testing appropriate to each acquisition is strongly supported. The qualification requirement verification process specified herein is in accordance with the guidelines.

Operational Test (OT) shall be conducted in support of the acceptance of the LGF in accordance with the requirements of this specification and operational requirements of the LAAS RD. OT is normally conducted with contractor support at the designated FAA test facility; the FAA William J. Hughes Technical Center (WJHTC). Development Test (DT), Production Acceptance Test (PAT), and Site Acceptance Test (SAT) are performed at the contractor facility and should reference the Verification Requirements Test Matrix (VRTM) in Appendix C.

For a non-government acquisition, certification is normally granted through a Type Acceptance program. Type Acceptance and OT may be conducted concurrently. For a non-government acquisition, it is not mandatory to conduct OT at the FAA designated facility. To support the FAA Government Industry Partnership (GIP), operational performance can be verified via government furnished aircraft and government furnished Time, Space, Position Information (TSPI) equipment. Raw data and results from the contractor and government could be pooled for analysis purposes.

4.1.1 General Testing Requirements

4.1.1.1 Development Test

DT activities shall be conducted to verify that the implemented hardware and software design meets the functional and performance requirements of the LGF specification. Specific tests for verification are not conveyed, but normally include the verification of software and hardware requirements, stability and dry running, and system level testing.

4.1.1.2 Production Acceptance Test

PAT shall be performed on each end-item before it leaves the factory to verify that the end-item conforms to applicable requirements, is free from manufacturing defects, and is substantially identical to the qualified system.

4.1.1.3 Site Acceptance Test

SAT is conducted after completion of hardware installation and checkout and the installation has been inspected and approved for workmanship and configuration. SAT is accomplished initially for the developmental system, and is repeated for each production system after PAT. Contractor-conducted testing shall be performed at each field site to verify that the new system is installed and operating properly on site.

4.1.1.4 Verification Methods

The LGF Test Program shall use the verification methods of Demonstration (D), Inspection (I), Analysis (A), and Test (T). These methods are defined as follows:

a. D – Demonstration is a method of verification where qualitative versus quantitative validation of a requirement is made during a dynamic test of the equipment. Demonstration activities are further characterized by the following:

    1. If a requirement is validated by test during first article qualification testing and the requirement has enough significance that it is re-tested during acceptance test, then this acceptance testing can be indicated in the VRTM as a Demonstration.

    2. Software functional requirements are validated by demonstration since the functionality must be observed through secondary media.

b. I – Inspection is a method of verification to determine compliance with specification requirements and consist primarily of visual observations, mechanical measurements of the equipment, physical locations, and technical examination of engineering-supported documentation.

c. A – Analysis is a method of verification that consists of comparing hardware or software design with known scientific and technical principles, technical data, or procedures and practices to validate that the proposed design will meet the specified functional and performance requirements. Analysis also includes the use of modeling and simulation.

d. T – Test is a method of verification that will measure equipment performance under specific configuration-load conditions and after the controlled application of known stimuli. Quantitative values are measured, compared against previous predicted success criteria, and evaluated to determine the degree of compliance.

Appendix A
Interference Environment

The interference environment shall be consistent with the following figures and tables (Figure H-1 of the MASPS, Figure H-2 of the MASPS, and Tables H-1 and H-2 of the MASPS). Reference Receivers shall meet the performance requirements of this specification when operated within the specified operating environment, given ranging signal levels of –130 dBm for the GPS satellite signals, –131 dBm for SBAS satellite signals, and as defined in Appendix D of RTCA DO-246 for Airport Pseudolites (APLs).

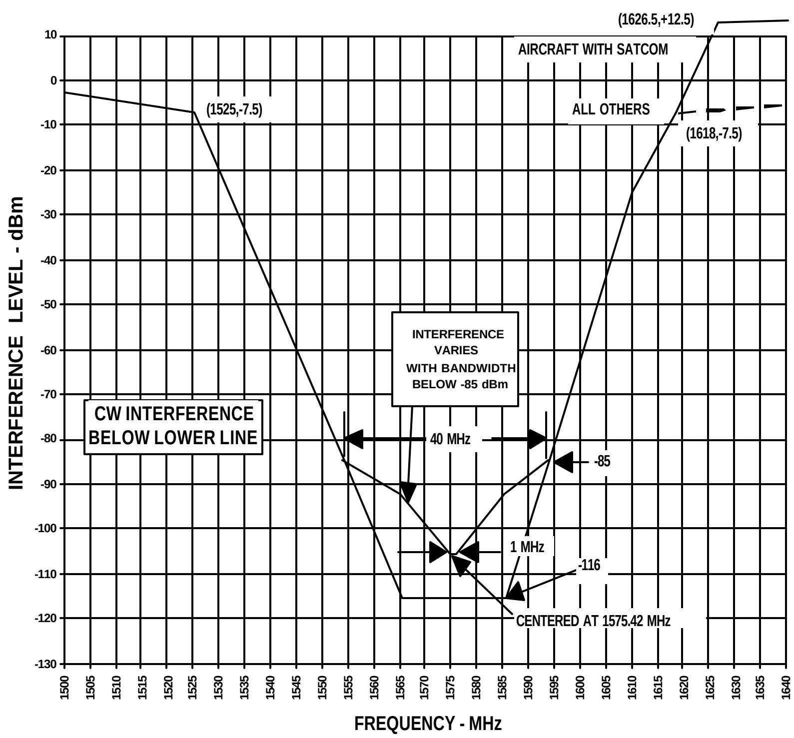


Figure A-1. H-1 (MASPS) Interference Levels At Output Of Idealized 0 Dbi Antenna

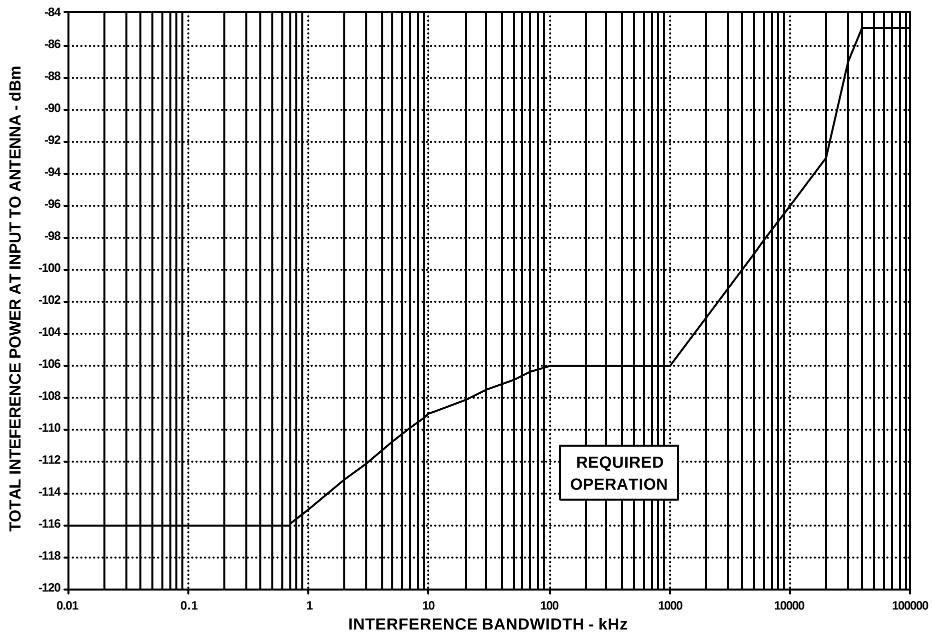


Figure A-2. H-2 (MASPS) In-Band and Near-Band Interference Environments

Table A-1. H-1 (MASPS) Out-of-Band Pulse Interference

	GPS/SBAS/APL	GPS/APL Only
Peak Power	+30 dBm	+30 dBm
Pulse Width	125 μsec	1 ms
Pulse Duty Cycle	10%	10%

Table A-2. H-2 (MASPS) In-Band And Near-Band Interference Bandwidth Definitions

BANDWIDTH	INTERFERENCE LEVEL
$0 \leq BW_I \leq 700$ Hz	-116 dBm
700 Hz $< BW_I \leq 10$ kHz	$-115 + 6 \log_{10}(BW_I/1000)$ dBm
10 kHz $< BW_I \leq 100$ kHz	$-109 + 3 \log_{10}(BW_I/10000)$ dBm
100 kHz $< BW_I \leq 1$ MHz	-106 dBm
1 MHz $< BW_I \leq 20$ MHz	Linearly increasing from -106 to -93 dBm*
20 MHz $< BW_I \leq 30$ MHz	Linearly increasing from -93 to -87 dBm*
30 MHz $< BW_I \leq 40$ MHz	Linearly increasing from -87 to -85 dBm*
40 MHz $< BW_I$	-85 dBm*

*Interference levels will not exceed -106 dBm/MHz in the frequency range of 1575.42 ± 10 MHz.

Appendix B
Configuration Management and Quality Control

B – 1. Configuration Management

Configuration Management for the FAA is implemented in accordance with MIL-HDBK-61 and EIA-649. FAA CM includes, but is not limited to, the following:

a. Configuration Control Board
Configuration Control Boards (CCB) are established to evaluate all proposed changes to a CI. The CCB also advises the CCB Chair on disposition of a change.

b. Configuration Identification
Configuration identification includes the selection, description, and naming of the physical and functional characteristics of a system. Configuration Items (CI) are those specification items whose functions and performance parameters must be defined and controlled to achieve the overall end use function and performance.

c. Configuration Control
Configuration control is implemented to manage changes to the established and agreed upon baseline of all identified CIs. Any proposed change to a CI must go through a formal evaluation and approval process. Configuration control processes also maintain interfaces and support interoperability.

d. CM Audits
Configuration audits are conducted to verify accomplishment of development requirements and achievement of a product through examination of the technical documentation. An audit validates traceability of baseline changes from source to object, source to listing, source to documentation, and source to requirement. Audits also validate incorporation of approval changes and provide integrity for baselines.

e. Configuration Status Accounting
Configuration status accounting activities are conducted to record and report information necessary to manage CIs. Records and reports include records of approved configuration documentation and CI numbers; reports on the status of proposed changes, deviations and waivers; and reports on the implementation status of approved changes.

B – 2. Quality Control

A Quality Control Program Plan for the LGF is also developed. This plan should include procedures for monitoring and evaluating the processes of configuration management, facilities management, and system verification. Procedures for evaluating the systems for controlling Government Furnished Equipment (GFE), NDI, and Commercial off-the-Shelf (COTS) equipment are provided.

Appendix C
Verification Requirements Traceability Matrix

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	Remarks
3.1				LAAS Ground Facility General Requirements				Title
3.1.1				Coverage Volume				Definitions only
3.1.1.1				Approach Coverage Volume	T, A			
3.1.1.2				VDB Coverage Volume	T, A	T	T	For DT - antenna tested on antenna range over frequency band; transmitter tested over temperature and humidity conditions
3.1.2				Integrity				Title
3.1.2.1				Integrity of Ranging Sources	A			
3.1.2.2				Integrity of the Ground Facility	A			
3.1.2.3				Integrity of a Single RR	A			
3.1.2.4				Latent Failures	A			
3.1.3				Continuity				Title
3.1.3.1				VHF Data Broadcasting Transmission Continuity	A			
3.1.3.2				RR and Ground Integrity Monitoring Continuity	A			
3.1.3.3				Latent Failures Affecting Continuity	A, T			
3.1.4				States and Modes				Title
3.1.4.1				States	D	D	D	
	a			LGF On	D	D	D	

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	Remarks
	b			LGF Off	D	D	D	
3.1.4.2				Modes	D	D	D	
	a			Normal	D	D	D	
	b			Not Available	D	D	D	
	c			Test	D	D	D	
3.1.4.3				Normal Mode	D	D	D	
	a			Conditions	D	D	D	
		1		Alert	D	D	D	
		2		Service Alert	D	D	D	
		3		Constellation Alert	D	D	D	
	b			Actions	D	D	D	
		1		Approach Control	D	D	D	
		2		Periodic Maintenance	D	D	D	
		3		Non-Intrusive Diagnostics	D	D	D	
		4		LRU Replacement	D	D	D	
		5		Data Recording	D	D	D	
		6		Status Monitoring	D	D	D	
		7		User ID and Password Change	D	D	D	
		8		Adjustment Storage	D	D	D	
		9		Automatic Restart	D	D	D	

Paragraph				Requirement	Verification Level and Method DT	PAT	SAT	Remarks
		10		Fault Recovery	D	D	D	
	c			Transition criteria				Title
		1		Entering Normal Mode	D	D	D	
			a	From Off State	D	D	D	
			b	From Test Mode	D	D	D	
			c	From Not Available Mode	D	D	D	
		2		Exiting Normal Mode	D	D	D	
			a	To Not Available Mode	D	D	D	
			b	To Test Mode	D	D	D	
3.1.4.4				Not Available Mode	D	D	D	
	a			Condition	D	D	D	
		1		Alarm	D	D	D	
	b			Actions	D	D	D	
		1		Automatic restart	D	D	D	
		2		States and modes display	D	D	D	
		3		System power display	D	D	D	
		4		System events recording	D	D	D	
	c			Transition criteria				Title
		1		Entering Not Available Mode	D	D	D	
			a	From Normal Mode	D	D	D	

Paragraph				Requirement	Verification Level and Method DT	PAT	SAT	Remarks
			b	From Test Mode	D	D	D	
		2		Exiting Not Available Mode	D	D	D	
			a	To Normal Mode	D	D	D	
			b	To Test Mode	D	D	D	
3.1.4.5				Test Mode	D	D	D	
	a			Conditions				
		1		Alert	D	D	D	
		2		Service Alert	D	D	D	
		3		Constellation Alert	D	D	D	
		4		Alarm	D	D	D	
	b			Maintenance and Test Actions				
		1		Reset the LGF				
		2		Intrusive and non-intrusive diagnostics				
		3		Trouble shooting				
		4		Site specific parameter change				
		5		Alerts and alarms threshold change				
		6		Redundant equipment status change				
		7		Monitor bypass				
		8		VDB bypass				
		9		Approach Control	D	D	D	

Paragraph				Requirement	Verification Level and Method DT	PAT	SAT	Remarks
		10		Periodic Maintenance	D	D	D	
		11		LRU Replacement	D	D	D	
		12		Data Recording	D	D	D	
		13		Status Monitoring	D	D	D	
		14		User ID and Password Change	D	D	D	
		15		Adjustment Storage	D	D	D	
		16		Fault Recovery	D	D	D	
	c			Transition criteria				
		1		Entering Test Mode	D	D	D	
			a	From Normal	D	D	D	
			b	From Not Available	D	D	D	
		2		Exiting Test Mode	D	D	D	
			a	To Normal	D	D	D	
			b	To Not Available	D	D	D	
3.1.5				Executive Monitoring				Title
3.1.5.1				Fault Monitoring	D			
				Table 3-1	D			
				Table 3-2	D			
3.1.5.1.1				Fault Recovery	D			
3.1.5.1.2				Generation of Alerts	T			

Paragraph				Requirement	DT	PAT	SAT	Remarks
					Verification Level and Method			
3.1.5.1.3				Generation of Service Alerts	T			
3.1.5.1.4				Generation of Constellation Alert	T			
3.1.5.1.5				Generation of Alarms	T			
	a			Number of measurements set to zero	T			
	b			VDB terminated	T			
3.1.5.1.5.1				Automatic Restart	T	T	T	
3.1.6				Software Design Assurance	I			
3.1.7				Complex Electronic Hardware Design Assurance	I			
3.2				Data Broadcast				Title
3.2.1				Broadcast Data Requirements	D	D	D	Demonstration of manually entered data
3.2.1.1				LAAS Message Block	I			
3.2.1.1.1				Message Block Header				Title
3.2.1.1.1.1				Message Block Identifier	T			
3.2.1.1.1.2				Ground Station Identification	T			
3.2.1.1.1.3				Message Type Identifier	T			
3.2.1.1.1.4				Message Length	T			
3.2.1.1.2				Message	T			
3.2.1.1.3				Cyclic Redundancy Check	T			
3.2.1.2				Type 1 Message – Differential Corrections	T	T	T	
3.2.1.2.1				Modified Z-Count	T			

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	Remarks
3.2.1.2.2				Additional Message Flag	T			
3.2.1.2.3				Number of Measurements	T	T	T	
3.2.1.2.4				Measurement Type	T	T	T	
3.2.1.2.5				Ephemeris Cyclic Redundancy Check	T	T		
3.2.1.2.6				Source Availability Duration	T	T		
3.2.1.2.6.1				Reception Mask	T	T	T	
3.2.1.2.7				Ranging Source Measurement Block	T	T		
3.2.1.2.7.1				Ranging Source Identification	T	T		
3.2.1.2.7.2				Ranging Signal Sources	T	T		Title
	a			GPS SPS signals	T	T		
	b			SBAS signals	T	T		
3.2.1.2.7.3				Conditions for Transmitting the Ranging Source Measurement Block				Title
3.2.1.2.7.3.1				Valid GPS Ranging Sources	T,A			
	a			signal deformation;	T			
	b			RF Interference (RFI) in excess of levels defined in Appendix A;	T			
	c			signal levels below those specified in the GPS SPS Signal Spec	T			
	d			code/carrier divergence;	T			
	e			Excessive acceleration	T			

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	Remarks
3.2.1.2.7.3.2				Valid SBAS Ranging Sources	T,A			
	a			RFI in excess of levels defined in Appendix A;	T			
	b			signal levels below WAAS Specification FAA-E-2892B	T			
	c			code/carrier divergence;	T			
	d			Excessive acceleration	T			
3.2.1.2.7.3.3				Valid GPS Navigation Data				Title
	a			Three or more parity errors	T			
	b			IODE does not match IODC	T			
	c			HOW set to one	T			
	d			All data bits are zeros in subframes 1, 2 or 3	T			
	e			Default navigation data transmitted	T			
	f			Preamble does not equal 8B	T			
	g			All RRs have not decoded same ephemeris	T			
	h			Broadcast ephemeris orbit more than 7000 m from almanac orbit	T			
	i			Pseudorange correction or rate exceeded	T			
	j			“Do not use” message from SBAS	T			
	k			Ephemeris CRC changes, IODE doesn't	T			
	l			Decoded PRN is 37	T			
3.2.1.2.7.3.4				Valid SBAS Navigation Messages				Title

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	Remarks
	a			three or more parity errors	T			
	b			all RRs not decoded the same ephemeris and clock data;	T			
	c			Broadcast ephemeris orbit more than 200 km from almanac orbit	T			
	d			Differences in position greater than 0.12 m in last 4 minutes	T			
	e			More than 4 minutes elapsed since last SBAS navigation message	T			
	f			Pseudorange correction or rate exceeded	T			
	g			“Do not use” message from SBAS	T			
3.2.1.2.7.4				Issue of Data	T			
3.2.1.2.7.5				Pseudorange Corrections	D			
3.2.1.2.7.5.1				Smoothed Pseudorange				Title
	a			Correlator spacing 0.1 chip	A,I			
	b			Tracking loop bandwidth > 0.125 Hz	A,I			
	c			Strongest peak tracked	A,I			
3.2.1.2.7.5.2				GPS Predicted Range	T,I			
3.2.1.2.7.5.3				SBAS Predicted Range	T,I			
3.2.1.2.7.5.4				GPS Smoothed Pseudorange Correction	T,I			
3.2.1.2.7.5.5				SBAS Smoothed Pseudorange Correction	T,I			

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	Remarks
3.2.1.2.7.5.6				Broadcast Correction	T,I			
				Calculated according to equations 5 and 6	A, I			
	a			If Nc is less than four, no corrections provided	T			
	b			M shall be at least 3 for the fault free configuration.	I	I	I	
	c			Each RR measurement (m,n) updated at 2 Hz rate.	T	T		
	d			Each RR measurement (m,n) shall be identical signal processing.	A,I	I		
3.2.1.2.7.5.6.1				Correction Errors				Title
	a			smoothing filters have converged	T			
	b			the magnitude of the associated B-values within tolerance for GPS	T			
	c			the magnitude of the associated B-values within tolerance for SBAS	T			
	d			the magnitude of the pseudorange correction does not exceed 327.67 m	T			
3.2.1.2.7.6				Pseudorange Correction Rate	T			
3.2.1.2.7.6.1				Condition for Valid Pseudorange Correction Rate	T			
	a			Pseudorange correction rate does not exceed +/-3.4 m/s	T			
	b			Standard deviation does not exceed 4.0 cm per second	T			
3.2.1.2.7.6.1.1				Pseudorange correction rate monitor	T			

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	Remarks
3.2.1.2.7.7				Sigma Pseudorange Ground	A,T			
	a			VPL_{H0} and LPL_{H0} bound user error	A,T		T	
	b			VPL_{H1} and LPL_{H1} bound user error	A,T		T	
				σ_{pr_gnd} complies with equation 11 and table 3-5	T		T	DT over temperature and humidity
3.2.1.2.7.7.1				Condition for Valid Sigma Pseudorange Ground	A,D			Title
3.2.1.2.7.8				B-Values	T	D	D	
3.2.1.3				Type 2 Message – Differential Reference point	T	T	T	
3.2.1.3.1				Installed Receivers	T	D	D	
3.2.1.3.2				Accuracy Designator	T	D	D	
3.2.1.3.3				Continuity and Integrity Designator	T	D	D	
3.2.1.3.4				Local Magnetic Variation	T	D	D	
3.2.1.3.5				Refractivity Index	T	D	D	
3.2.1.3.6				Scale Height	T	D	D	
3.2.1.3.7				Refractivity Uncertainty	T	D	D	
3.2.1.3.8				Latitude	T	D	D	
3.2.1.3.9				Longitude	T	D	D	
3.2.1.3.10				Vertical Ellipsoid Offset	T	D	D	
3.2.1.4				Type 4 Message – FAS Data	T	D	D	
3.2.1.4.1				Data Set Length	T	D	D	
3.2.1.4.2				Final Approach Segment Data Block	T	D	D	

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	Remarks
3.2.1.4.2.1				Operation Type	T	D	D	
3.2.1.4.2.2				SBAS Provider Identification	T	D	D	
3.2.1.4.2.3				Airport Identification	T	D	D	
3.2.1.4.2.4				Runway Number	T	D	D	
3.2.1.4.2.5				Runway Letter	T	D	D	
3.2.1.4.2.6				Approach Performance Designator	T	D	D	
3.2.1.4.2.7				Route Indicator	T	D	D	
3.2.1.4.2.8				Reference Path Data Selector	T	D	D	
3.2.1.4.2.9				Reference Path Identifier	T	D	D	
3.2.1.4.2.10				LTP/FTP Latitude	T	D	D	
3.2.1.4.2.11				LTP/FTP Longitude	T	D	D	
3.2.1.4.2.12				LTP/FTP Threshold Height	T	D	D	
3.2.1.4.2.13				Flight Path Alignment Point Latitude	T	D	D	
3.2.1.4.2.14				Flight Path Alignment Longitude	T	D	D	
3.2.1.4.2.15				Approach Threshold Crossing Height	T	D	D	
3.2.1.4.2.16				Approach Threshold Crossing Height Unit Selector	T	D	D	
3.2.1.4.2.17				Glidepath Angle	T	D	D	
3.2.1.4.2.18				Course Width	T	D	D	
3.2.1.4.2.19				Delta Length Offset	T	D	D	
3.2.1.4.2.20				Final Approach Segment Cyclic Redundancy Check	T	D	D	

Paragraph				Requirement	Verification Level and Method DT	PAT	SAT	Remarks
3.2.1.4.3				Final Approach Segment VAL/App status	T	D	D	
3.2.1.4.4				Final Approach Segment LAL/App status	T	D	D	
3.2.2				RF Transmission Characteristics and Broadcast Monitoring				Title
3.2.2.1				Symbol Rate	T			
3.2.2.2				Emission Designator	I			
3.2.2.3				Antenna Polarization	T			
3.2.2.4				Field Strength	T			Test over frequency band, temperature and humidity
3.2.2.4.1				Measured field strength	T			
				Horizontal minimum 215 μV/m	T			
				Horizontal maximum 350 V/m	T			
				Vertical minimum 136 μV/m	T			
				Vertical maximum 221 V/m	T			
3.2.2.4.2				Phase offset	T			
3.2.2.5				Spectral Characteristics				Title
3.2.2.5.1				Carrier Frequencies	T	T		DT over frequency band
3.2.2.5.2				Spurious Emissions	T			Test over frequency band
3.2.2.6				Adjacent Channel Emissions	T			Test over frequency band
3.2.2.6.1				Adjacent Temporal Interference	T			Test over frequency band
3.2.2.6.2				Frequency Stability	T			Test over temperature and humidity

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	Remarks
3.2.2.7				Modulation	T,I			
3.2.2.7.1				Pulse Shaping Filters	T,I			
3.2.2.7.2				Error Vector Magnitude	T,I			
3.2.2.8				Message Encoding	T,I			
3.2.2.9				Broadcast Timing Structure Division Multiply Access	T,I			
3.2.2.10				Message Format	T,I			
3.2.3				RF Broadcast Monitoring				Title
	a			Disagreement between transmitted and stored data for 3 seconds	T	D		
	b			Change in transmitted power by 3 dB	T	D		
	c			More than 0.2% of messages not transmitted	T	D		
	d			No transmission for 3 seconds	T	D		
	e			Data out of TDMA slot for 3 seconds	T	D		
3.3				Operation and Maintenance				Title
3.3.1				System Requirements				Title
3.3.1.1				Environmental Design Values	T			
3.3.1.1.1				Environmental Service Conditions	T			
3.3.1.1.2				Wind and Ice Loading	T			
3.3.1.1.3				Non-Operating Conditions	T			
3.3.1.2				Primary Power	T	T		

Paragraph				Requirement	Verification Level and Method DT	PAT	SAT	Remarks
3.3.1.3				Supplementary Power	T	T	D	
3.3.1.3.1				Power Supply	T	D	D	
3.3.1.4				Environmental Sensors				Title
	a			intrusion detector sensor,	I	I	I	
	b			smoke detector sensor,	I	I	I	
	c			obstruction lights sensor,	I	I	I	
	d			AC power sensor,	I	I	I	
	e			inside temperature sensor,	I	I	I	
	f			outside temperature sensor.	I	I	I	
3.3.1.4.1				Intrusion Detector	T			
3.3.1.4.2				Smoke Detector	T			
3.3.1.4.3				Obstruction Lights	T			
3.3.1.4.4				Alternate Current Power	T			
3.3.1.4.5				Inside Temperature	T			
3.3.1.4.6				Outside Temperature	T			
3.3.1.5				Fault Diagnostics	D	D	D	
	a			automatic diagnostics when alarm occurs.	D	D	D	Test sample of simulated failures
	b			Fault isolation 90% to group of three LRUs or less using automatic diagnostics.	T	D	D	“ “
	c			Manual isolation to a single LRU - 100%	D			“ “

					Verification Level and Method			
Paragraph				**Requirement**	**DT**	**PAT**	**SAT**	**Remarks**
3.3.1.6				Maintainability of Electronic Equipment				Title
3.3.1.6.1				Maintenance Concept	I			
3.3.1.6.2				Unscheduled Maintenance				Title
3.3.1.6.2.1				Reliability	A			
3.3.1.6.2.2				Maintainability	A			
	a			diagnostic time,	T			Test sample of simulated failures
	b			removal of the failed LRU,	T			“ “
	c			replacement of the new LRU,	T			“ “
	d			initialization of the new LRU,	T			“ “
	e			all adjustments required to return the LGF to normal operation.	T			“ “
3.3.1.6.3				Periodic Maintenance	D,A			Demonstration of sample PM tasks
3.3.1.6.4				System specialist workload	D,A			
3.3.1.7				Security	D			
3.3.1.7.1				System Identifiers and Authenticators	D			
3.3.1.7.1.1				Security Levels	D		D	
3.3.1.7.1.2				Read Access	D		D	
3.3.1.7.1.3				Write Access	D		D	
3.3.1.7.2				User Identifications and Passwords	D,I			
3.3.1.7.3				Invalid User Identification Entry				Title

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	Remarks
	a			an error message to be output to the MDT,	D			
	b			the security level access procedure to be terminated after 3 invalid entries	D			
	c			the LGF security process to return to an idle state.	D			
	d			Access inhibited for 15 min. after 3 invalid entries	D			
3.3.1.7.4				Invalid Password Entry				Title
	a			an error message to be output to the MDT,	D			
	b			the security level access procedure to be terminated after 3 invalid entries	D			
	c			the LGF security process to return to an idle state.	D			
	d			Access inhibited for 15 min. after 3 invalid entries	D			
3.3.1.7.5				Log-on Time-out	T			
3.3.1.8				Physical Design and Packaging	A,I			
3.3.1.8.1				Obstruction Lights	I			
3.3.1.9				Electrical				Title
3.3.1.9.1				Electrical Wiring	I			
3.3.1.9.1.1				External Wiring	I			
3.3.1.9.2				Alternating Current Line Controls	I			
3.3.1.9.3				Main Power Switch	I			
3.3.1.9.4				AC Line-Input Resistance to Ground	I			
3.3.1.9.5				AC Line Connectors and Power Cord	I			

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	Remarks
3.3.1.9.6				Alternating Current Line Controls	I			
3.3.1.9.7				Transformer Isolation, Direct Current Power Supplies	I			
3.3.1.9.8				Voltage Regulators	I			
3.3.1.9.9				Convenience Outlets	I			
3.3.1.9.10				Circuit Protection	I			
3.3.1.9.11				Electrical Overload Protection	I			
3.3.1.9.11.1				Current Overload Protection	I			
3.3.1.9.11.2				Protective Devices	I			
3.3.1.9.12				Circuit Breakers	I			
3.3.1.9.12.1				Short Circuit Coordination	I			
3.3.1.9.12.2				Normal Performance	I			
3.3.1.9.13				Test Points and Test Equipment	I			
3.3.1.9.13.1				Built in Test Device Requirements	I			
3.3.1.9.13.2				Location of Test Points and Adjustment Controls	I			
3.3.1.9.13.3				Test Point Circuitry Protection	I			
3.3.1.9.13.4				Failure	I			
3.3.1.9.14				Electrical Breakdown Prevention	I			
3.3.1.9.15				Grounding, Bonding, Shielding, and Transient Protection	I			
3.3.1.9.16				Obstruction Lights	I			

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	Remarks
3.3.1.9.17				Power Factor	I			
3.3.1.9.18				Peak Inrush Current	I			
3.3.1.10				Markings	I			
3.3.1.10.1				RF Connectors	I			
3.3.1.10.2				Fuse Markings	I			
3.3.1.10.3				Terminal Strips and Blocks	I			
3.3.1.10.4				Controls and Indicating Devices	I			
3.3.1.10.5				Nameplates	I			
3.3.1.10.6				Safety Related Markings	I			
3.3.1.10.6.1				Physical Hazards	I			
3.3.1.10.6.2				Center of Gravity	I			
3.3.1.10.7				Accident Prevention Signs and Labels	I			
3.3.1.10.8				Sign Design	I			
3.3.1.10.9				Sign Classification and Detailed Design	I			
3.3.1.10.9.1				Class I - Danger Classification	I			
3.3.1.10.9.2				Class II - Caution Classification	I			
3.3.1.10.9.3				Class III - General Safety Classification	I			
3.3.1.10.9.4				Class IV - Fire and Emergency Classification	I			
3.3.1.11				Personnel Safety and Health	I			
3.3.1.11.1				Human Factors Engineering	A,I			

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	Remarks
	a			Hazardous Components,	A,I			
	b			Safety-Related Interface Considerations	A,I			
	c			Environmental Constraints	A,I			
	d			Operating, Test, Maintenance, And Emergency Procedures,	A,I			
	e			Facilities And Support Equipment,	A,I			
	f			Safety Related Equipment, Safeguards	A,I			
3.3.1.11.2				Electrical Safety	I			
3.3.1.11.2.1				Ground Potential	I			
3.3.1.11.2.2				Hinged or Slide Mounted Panels and Doors	I			
3.3.1.11.2.3				Shielding	I			
3.3.1.11.2.4				RF Voltage Protection	I			
3.3.1.11.2.5				Electrical Connectors	I			
3.3.1.11.3				RF Limits	I			Title
3.3.1.11.3.1				Applicability of Federal Standards	A,I			
3.3.1.11.3.2				Radiation Hazards and Protection	A,I			
3.3.1.11.4				Cathode Ray Tubes	A,I			
3.3.1.12				Hazardous and Restricted Materials	A,I			
3.3.1.13				FCC Type Acceptance and Registration	T			
3.3.1.15				Preparation for Delivery				Title

Paragraph				Requirement	Verification Level and Method			Remarks
					DT	PAT	SAT	
3.3.1.15.1				Preservation and Packaging	I			
3.3.1.15.2				Packing	I			
3.3.2				Control and Display	A,I			
3.3.2.1				Local Status Panel	I			
3.3.2.1.1				LSP – Modes and Service Alerts	T	T	D	
3.3.2.1.1.1				LSP - Initialization	T	T	D	
3.3.2.1.2				LSP – Aural Signal	D	D	D	
3.3.2.1.3				LSP – Mute Switch	D	D	D	
3.3.2.2				Remote Status Panel	I			
3.3.2.2.1				RSP – Modes and Service Alerts	T	T	D	
3.3.2.2.1.1				RSP - Initialization	T	T	D	
3.3.2.2.2				RSP - Aural Signal	D	D	D	
3.3.2.2.3				RSP - Mute Switch	D	D	D	
3.3.2.2.4				RSP - Supplementary Power	D,A	D	D	
3.3.2.3				Maintenance Data Terminal	I			
3.3.2.3.1				MDT Control and Display	D	D	D	
3.3.2.3.1.1				Restart	D	D	D	
3.3.2.3.2				Status and Modes Display	D	D	D	
3.3.2.3.3				Alerts and Alarm Display	T	T	D	
3.3.2.3.4				VHF Data Broadcast Display	D	D	D	

					Verification Level and Method			
Paragraph				**Requirement**	**DT**	**PAT**	**SAT**	**Remarks**
3.3.2.3.5				VHF Data Broadcast Control	D	D	D	
3.3.2.3.6				VHF Data Broadcast Message Data	D	D	D	
	a			Message Header	D	D	D	
		1		Reference Station ID	D	D	D	
	b			Type 1 Message	D	D	D	
		1		Measurement Type	D	D	D	
	c			Type 2 Message	D	D	D	
		1		LGF Installed RRs	D	D	D	
		2		LGF Accuracy Designator	D	D	D	
		3		Local Magnetic Variation	D	D	D	
		4		Refractivity Index	D	D	D	
		5		Scale Height	D	D	D	
		6		Refractivity Uncertainty	D	D	D	
		7		Latitude	D	D	D	
		8		Longitude	D	D	D	
		9		Vertical Ellipsoid Offset	D	D	D	
	d			Type 4 Message	D	D	D	
		1		Data Set Length	D	D	D	
		2		FAS Data Block - manually entered as a block	D	D	D	
			a	Operation Type	D	D	D	

Paragraph				Requirement	Verification Level and Method DT	PAT	SAT	Remarks
			b	SBAS Provider Identification	D	D	D	
			c	Airport Identification	D	D	D	
			d	Runway Number	D	D	D	
			e	Runway Letter	D	D	D	
			f	Approach Performance Designator	D	D	D	
			g	Route Indicator	D	D	D	
			h	Performance Path Data Selector	D	D	D	
			i	Reference Path Identifier	D	D	D	
			j	LTP/FTP Latitude	D	D	D	
			k	LTP/FTP Longitude	D	D	D	
			l	LTP/FTP Height	D	D	D	
			m	FPAP Latitude	D	D	D	
			n	FPAP Longitude	D	D	D	
			o	TCH	D	D	D	
			p	TCH Unit Selector	D	D	D	
			q	GPA	D	D	D	
			r	Course Width	D	D	D	
			s	Delta Length Offset	D	D	D	
			t	FAS CRC	D	D	D	
		3		FAS VAL/Approach Status	D	D	D	

					Verification Level and Method			
Paragraph				**Requirement**	**DT**	**PAT**	**SAT**	**Remarks**
		4		FAS LAL/Approach Status	D	D	D	
3.3.2.3.7				System Power Display	D	D	D	
3.3.2.3.8				Alerts and Alarm Status Display	D	D	D	
3.3.2.3.9				Alerts and Alarm Threshold Display	D	D	D	
3.3.2.3.10				Alerts and Alarm Threshold Control	D	D	D	
3.3.2.3.11				Monitor By-pass	D	D	D	
3.3.2.3.11.1				By-pass annunciation	D	D	D	
3.3.2.3.11.2				By-pass actions	D	D	D	
3.3.2.3.12				Static Site Data Display	D	D	D	
	a			VDB Frequency	D	D	D	
	b			VDB Power	D	D	D	
	c			TDM Time Slot(s)	D	D	D	
	d			RR Geodetic Coordinates	D	D	D	
3.3.2.3.13				Static Site Data Control	D	D	D	
	a			VDB Frequency	T	D	D	
	b			VDB Power	T	D	D	
	c			TDM Time Slot(s)	T	D	D	
	d			RR Geodetic Coordinates	D	D	D	
3.3.2.3.14				Runway Data Display	D	D	D	
3.3.2.3.15				Runway Data Control	D	D	D	

Paragraph				Requirement	Verification Level and Method DT	PAT	SAT	Remarks
3.3.2.3.16				Redundant Equipment Status Display	D	D	D	
	a			Main - Primary LGF Equipment	D	D	D	
		1		On-line	D	D	D	
		2		Failed	D	D	D	
		3		Disabled	D	D	D	
	b			Standby - Backup/redundant LGF Equipment	D	D	D	
		1		Available	D	D	D	
		2		Failed	D	D	D	
		3		Disabled	D	D	D	
3.3.2.3.17				Redundant Equipment Control	D	D	D	
3.3.2.3.18				Diagnostics Display	D	D	D	
3.3.2.3.19				Diagnostics Control	D	D	D	
	a			Non-intrusive - LGF remains in Operational Mode	D	D	D	
	b			Intrusive - LGF is in Maintenance Mode.	D	D	D	
3.3.2.3.20				Temperature Display	D	D	D	
3.3.2.3.21				Adjustment Storage	A,I			
3.3.2.4				Remote Maintenance Interface	D,I	I	I	
3.3.2.5				ATCU	I			
3.3.2.5.1				ATCU - Approach Control	D	D	D	
3.3.2.5.2				ATCU – Operational Status Display	D	D	D	

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	Remarks
3.3.2.5.3				ATCU - Modes	D	D	D	
3.3.2.5.4				ATCU - Maintenance Display	D	D	D	
3.3.2.5.5				ATCU – Constellation Alert Display				
3.3.2.5.6				Aural Signal	D	D	D	
3.3.2.5.6.1				Audio Control	D	D	D	
3.3.2.5.7				Design Requirements	I,A			
3.3.2.5.7.1				Monitor Design Requirements				
	a			Configurable				
		1		Rack Mounted in Standard 19" Rack	I	I	I	
		2		Flush Mounted	I	I	I	
		3		Independent Workstation	I	I	I	
	b			Display Screen Attributes				
		1		14" Flat Color Screen LCD	I	I	I	
		2		Resolution of 800x600 and 72 dpi	I	I	I	
		3		Refresh Rate of Greater Than 70 Hz	I	I	I	
		4		160° Viewing Angle, Horz. and Vert.	D	D	D	
		5		Touch Screen	D	D	D	
		6		Visible Under all Lighting Conditions	D	D	D	
		7		Luminescence from 40 to 900 nits	I	I	I	

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	Remarks
		8		Anit-glare does not Reduce Light to less than 800 nits	D	D	D	
	c			External Components and Controls				
		1		Speaker	D	D	D	
		2		Volume Control	D	D	D	
		3		Brightness Control	D	D	D	
3.3.3				Recording				Title
3.3.3.1				System Events	D	D	D	
3.3.3.2				Events Recording	D	D	D	
3.3.3.3				VHF Data Broadcast Recording	D	D	D	
3.3.3.4				Reference Receiver Data	D	D	D	
3.3.4				Interface Requirements				Title
3.3.4.1				Local Status Panel Interface	I			
3.3.4.2				Remote Status Panel Interface	I			
3.3.4.3				MDT Interface				Title
3.3.4.4				ATCU Interface	I			
4				Verification				
4.1				Test Program				
4.1.1				General Testing Requirements				
4.1.1.1				Development Test	I			

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	Remarks
4.1.1.2				Production Acceptance Test	I			
4.1.1.3				Site Acceptance Test	I			
4.1.1.4				Verification Methods				
	a			Demonstration	I			
	b			Inspection	I			
	c			Analysis	I			
	d			Test	I			

Appendix D
Acronyms

Appendix E
Assumed Airborne Processing

The airborne receiver is assumed to be operating fault free and meeting all the performance requirements in the LAAS MASPS. The airborne receiver is assumed to be computing the Lateral Protection Limit (LPL)/Vertical Protection Limit (VPL), as defined in Section 3.1.3.4.6 of the LAAS MASPS.

Section 3.1.2.3 is intended to satisfy the prior probability of a RR failure assumed in the H_1 VPL/HPL equation.

Section 3.2.1.2.7.3.1 (a) defines parameters for detecting a distorted GPS signal. The parameters are based on the airborne tracking constraints contained in the LAAS MOPS and summarized here for convenience. Table E-1 specifies the regions where an airborne receiver is allowed to operate such that the LGF will insure that a distorted signal as described in Section 3.2.1.2.7.3.1 (a) of the LGF specification can be detected. Operating outside of this region, the LGF cannot guarantee the integrity of the GPS correction associated with that satellite.

Table E-1. GPS Tracking Constraints

Region in Figure E -1	3 dB Pre-Correlation Bandwidth, BW	Average Correlator Spacing	Instantaneous Correlator Spacing	Differential Group Delay
1	0 < BW ≤ 7 MHz	0.045 – 1.1	0.04 – 1.2	(no constraint)
2	7 < BW ≤ 16 MHz	0.045 – 0.21	0.04 – 0.235	≤ 150 ns
3	16 < BW ≤ 20 MHz	0.045 – 0.12	0.04 – 0.15	≤ 150 ns

Figure E-1 is a representation of the protected region specified in Table E-1.

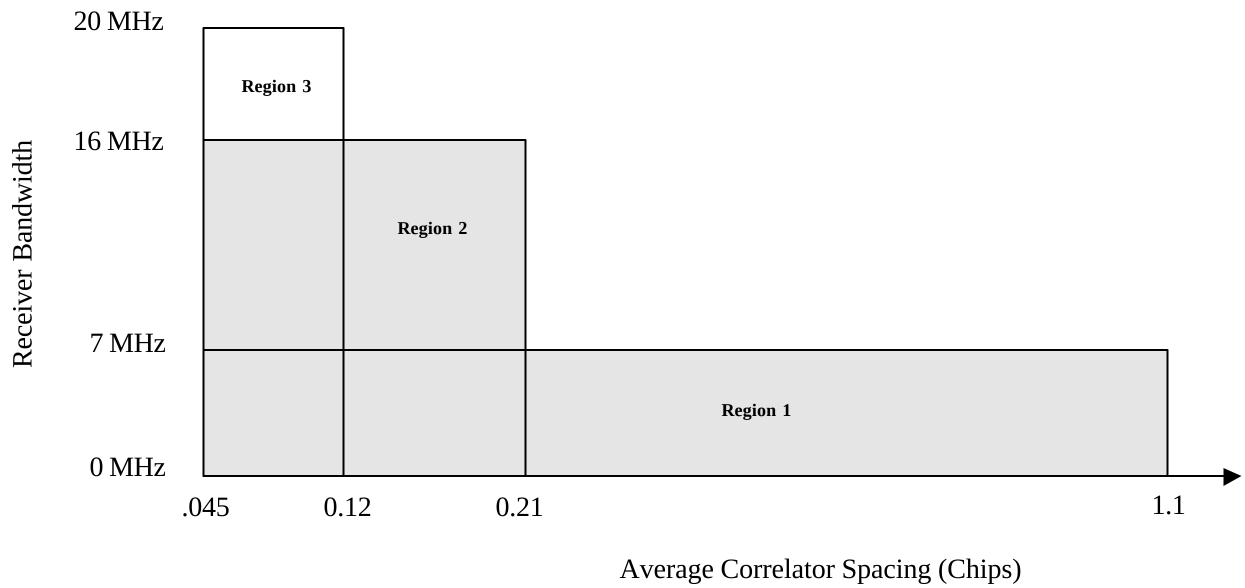


Figure E-1. Receiver Bandwidth vs. Average Correlator Spacing

The instantaneous correlator spacing is defined as the spacing between a particular set of early and late samples of the correlation function. The average correlator spacing is defined as a one-second average of the instantaneous correlator spacing. The average applies over any one-second time frame.

The discriminator (Δ) is based on an average of correlator spacing within the specified range, or is a discriminator of the type $\Delta = 2\Delta_{d1} - \Delta_{2d1}$, with d_1 and $2d_1$ in the specified range. Either a coherent or a non-coherent discriminator may be used.

The differential group delay applies to the entire aircraft installed system prior to the correlator, including the antenna. The differential group delay is defined as

$$\left| \frac{d\phi}{d\omega}(f_c) - \frac{d\phi}{d\omega}(f_{3dB}) \right|$$

where f_c is the pre-correlation band pass filter center frequency,

f_{3dB} are the 3dB cut off points of the filter,

ϕ is the phase response of pre-correlation band pass filter, and

ω is the frequency.

Appendix F
Operational Considerations

This appendix describes operational considerations for LAAS that are an extension of the basic Category I level of service. Additional descriptions on tuning the LAAS approach and future applications can be found in the FAA LAAS Concept of Operations Document.

F - 1. PRE-FLIGHT PLANNING

Pre-flight planning should be similar to the requirements for current source referenced (VOR, DME, NDB, TACAN etc.) navigation and approach systems. This includes checking for service availability (e.g., satellite geometry), weather, alternate planning, and other similar actions to planning for the route of flight and destination. A NAS-wide information system (i.e., NOTAMS) distributes timely and consistent information across the NAS for both user and service provider planning.

The pilot should follow the specific start-up and self-test procedures for the GPS receiver as outlined in the FAA AFM or Flight Manual Supplement. Aircraft that are navigating by GPS are considered to be RNAV-equipped aircraft and the appropriate equipment suffix should be included in the Air Traffic Control (ATC) flight plan.

F - 2. TERMINAL

Terminal navigation operations are dependent upon the ability to position aircraft within the designated operational coverage of GPS/LAAS. GPS/LAAS may be tuned and used to correct aRrea NAVigation (RNAV) position during en-route and terminal operations using the Position, Velocity, and Time (PVT) output of the GPS/LAAS receiver in conjunction with a suitable RNAV system. The enunciated navigation source will indicate the lateral navigation mode, and that GPS/LAAS is selected and available.

F - 3. TUNING AND ANNUNCIATION

Pilots will select the LAAS/GPS approach for the runway of intended landing and tune the receiver to the LGF frequency to establish the data link (data channel), which provides the precision guidance for the GPS/LAAS final approach. After GPS/LAAS is tuned and the approach is selected, deviation indicators and the shortest distance for the aircraft to the threshold are displayed to the pilot. The display of deviation data is independent of the minimums to which the operation is being conducted. The needle sensitivity on the display indicator for both lateral and vertical deviations increases due to the emulation of an angular convergence of the localizer and glide slope origins.

F - 4. FLIGHT INSTRUMENT PRESENTATION

F - 4.1. Lateral Deviation

The LAAS airborne equipment provides proportional guidance for lateral course deviation and vertical path deviation within a $\pm 35°$ lateral sector about the final approach path.

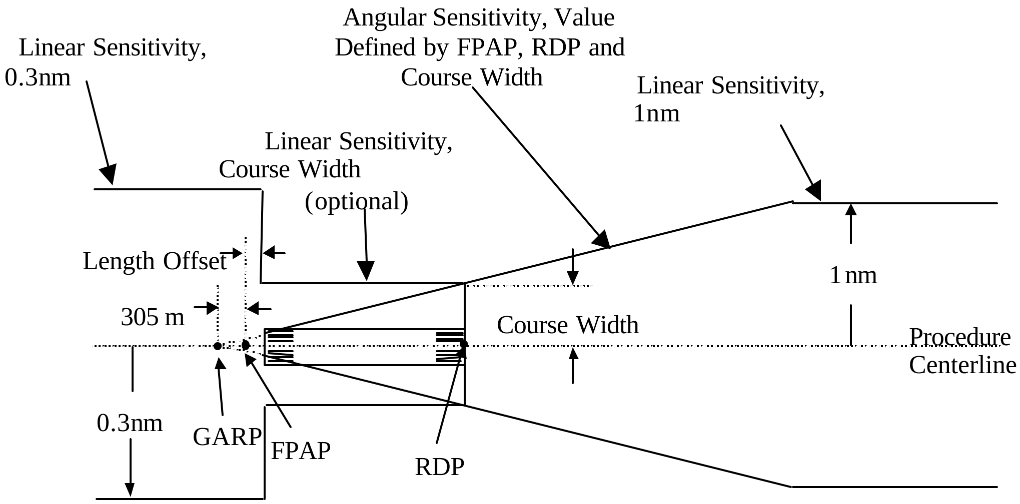


Figure F-1. Lateral Deviation

Lateral full-scale deviation can be based upon two independent characteristics, angular or linear. When an aircraft is outside of the 35° lateral guidance area, full-scale deviation is displayed. Lateral deviation, in all cases, is linear and has a width of ±1.0 nm to a point approximately 28 nm from the landing threshold. At this point, lateral deviation decreases angularly (at between 1.5° and 2.0°) to a point ±350 ft abeam the landing threshold. Lateral deviation at the threshold may continue either angularly or linearly. Angular lateral deviation mirrors current precision approaches to the departure end of the runway. Alternatively, lateral deviation may continue linearly, ±350 ft from the runway centerline to the departure end of the runway. At the departure end of the runway, lateral deviation is linear (±0.3 nm from the extended runway centerline) to a transition point (turn guidance, alternative clearance) or to the limits of the standard service volume.

F - 4.2. Vertical Deviation

The vertical path deviation display has a dynamic range less than or equal to

a. ±10 ft at runway threshold, increasing with along-track distance at a splay angle of ± the final approach segment glide path angle divided by four and

b. maximum deviation dynamic range is ±500 ft.

The resolution of the vertical path deviation data available for display is at least 1/256 of the full-scale deviation value. The vertical deviation display, as well as the display dynamic range, is updated at a minimum of 5 Hz.

F - 4.3 Distance

The distance to runway threshold display is displayed as the total distance from the aircraft measured position to the runway threshold, with a range of 60 nm and a resolution of 0.1 nm.

F - 5 LOSS OF GPS/LAAS GUIDANCE

During any phase of the LAAS Category I approach, when the LAAS service degrades to the level where the system can no longer provide lateral guidance, or lateral and vertical guidance with the required level of safety, the pilot is alerted that both the lateral and vertical guidance is invalid, consistent with the current presentations of the particular cockpit. Anytime an aircraft loses lateral guidance during an approach, the pilot will comply with missed approach instructions or proceed visually and notify Air Traffic Control (ATC).

In the event that the GPS/LAAS service degrades such that the vertical guidance can no longer be provided with the required level of service but the lateral guidance is valid, the pilot is alerted that the vertical guidance only is invalid. In this condition, the aircraft may continue the approach to the published lateral minimums.

F – 6. CATEGORY I PRECISION APPROACH OPERATIONS

The service provided by Category I precision systems ILS and MLS supports the standard decision height to 200ft (60m) and visibility to ½ statute mile (800m) or runway visual range (RVR) to 1800ft (550m). These systems will also support autoland and heads-up display (HUD) guidance systems to Category II minimums when authorized by appropriate Operations Specification. The service provided by LAAS will support the same minimums, operations, and procedures as current precision landing systems (ILS and MLS) including parallel dependent/independent operations.

F - 6.1.LANDING/ROLLOUT

Category I LAAS will support autoland for exercising system under Category I visibility conditions, unless otherwise stated on the published approach.

F - 6.2.CAT I MISSED APPROACH

During missed approach the GPS/LAAS flight instrument display will change from an angular to linear display with a $\pm$ 0.3 nm sensitivity and full scale deflection of the CDI when the aircraft position is past the LTP (i.e., when distance to LTP is a negative value), the Altitude is $\geq$ TDZE (or LTP altitude) plus 200 ft (CAT II), and glideslope deviation is $\geq 150\ \mu\alpha$ (full scale delection) above the center of the glideslope. This will be maintained to a transition point (turn guidance, alternative clearance) or to the limits of the standard service volume.

F - 6.3.LOSS OF GPS/LAAS GUIDANCE

For LAAS Category I approach, during any phase of the approach, when the LAAS service degrades to the level where the system can no longer provide guidance with the required level of safety, the pilot is to be alerted that the guidance is invalid, consistent with the current presentations of the particular cockpit.

In the event that the LAAS service degrades such that the vertical guidance can no longer be provided with the required level of safety; however, the aircraft is established on the approach on the glidepath, the aircraft may continue to published lateral minimums. If the lateral function does not meet operational requirements vertical and lateral guidance is "flagged" and the approach is discontinued. If the full LAAS capability is unavailable prior to glidepath intercept, the aircraft must revert to another form of navigation.

F – 6.4. DISPLACED THRESHOLD OPERATIONS

When an airport closes a segment of a runway, the landing threshold is displaced. Airport Management and Airway facilities prepare NOTAMS advising users of the runway status and appropriate NAVAID limitations. Under these conditions, Airway Facilities removes the vertical guidance until normal runway operations resume. If sufficient lead time is available, precision approaches to a displaced threshold can be flight checked for accuracy and implemented. This will increase CFIT protection by having a precision approach, as well as maintain airport capacity by enabling operations to continue without having to use a non-precision approach to the runway or changing to a non-optimum runway configuration.

The capability to remove vertical guidance allows for continued non-precision operations to a displaced threshold mirroring operations in today's air traffic management system

F - 7. LOW VISIBILITY SURFACE OPERATIONS

LAAS will support future capabilities for surface navigation and dependent surveillance for aircraft and vehicles. This capability is provided through the PVT output and requires an RNAV capability (e.g., GPS or FMS). Future LAAS-based ground navigation capabilities are anticipated to include the ability to provide specified paths points and instructions through the VHF Data Broadcast (VDB) data link, and communications with the ground controller through other digital data links.

The objectives of LAAS-based ground navigation in an Advanced Surface Movement Guidance and Control System (A-SMGCS) include:

a. improve airport safety by preventing runway incursion and aircraft conflicts;

b. improve airport capacity through the more efficient, direct, and coordinated paths to and from runways and gates;

c. achieve savings through reduced taxi times and provide the most efficient paths between runways and gates.

F - 8. USAGE OF LGF TEST AND ALARM INDICATORS

RTCA/DO-246 allows for several fields wherein an approach is deemed unusable. A description of those fields and there usage is described.

F - 8.1. Message Block Identifier

The message block identifier is part of the message header and is part of each message broadcast. For Performance Type 1 (PT1), the LGF will broadcast Type 1, Type 2 and Type 4 messages, as defined in DO-246 (unless noted otherwise). When the message block header is 1010 1010, it is an indication that the message can be used for navigation. When the message block header is 1111 1111, it is an indication that the message can not be used for navigation and is officially called "Test" in both DO-246 and the International Civil Aviation Organization (ICAO) Ground Based Augmentation System (GBAS) document. The LGF specification requires a "Test Mode" in which test conditions can be run or the system is in undergoing maintenance that may cause the conditions of the LGF radiated signal to be out of tolerance. Flight inspection will have the capability to override the test message block header to flight check the LGF signal without concern that the flying public may use the signal, even if it is NOTAMed out. This is not as much of a concern for users wishing to fly an approach using the LGF signal, but more for operators in the en-route or terminal area that may be unaware of the NOTAM.

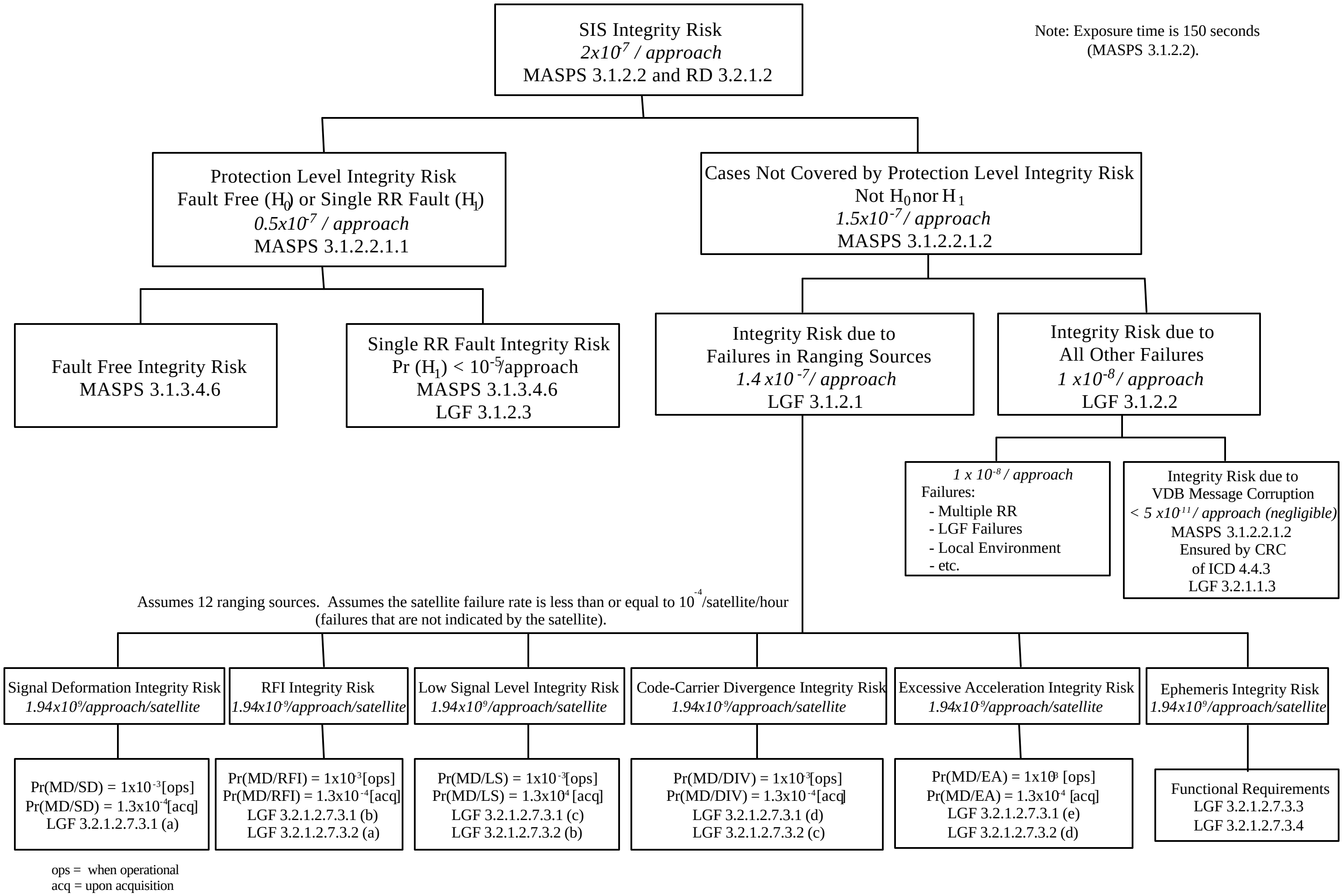
F - 8.2. Blank Type 1 Messages

The Type 1 message provides a "Number of Measurements" field which indicates the number of pseudorange corrections contained in the message. When this field is set to zero, the approach is immediately canceled (flagged) by the LAAS airborne receiver. This message field will be utilized to indicate an alarm at the LGF. The time from when the fault is detected to when it is annunciated at the aircraft includes the fact that the Type 1 message is broadcast at 2 Hz.

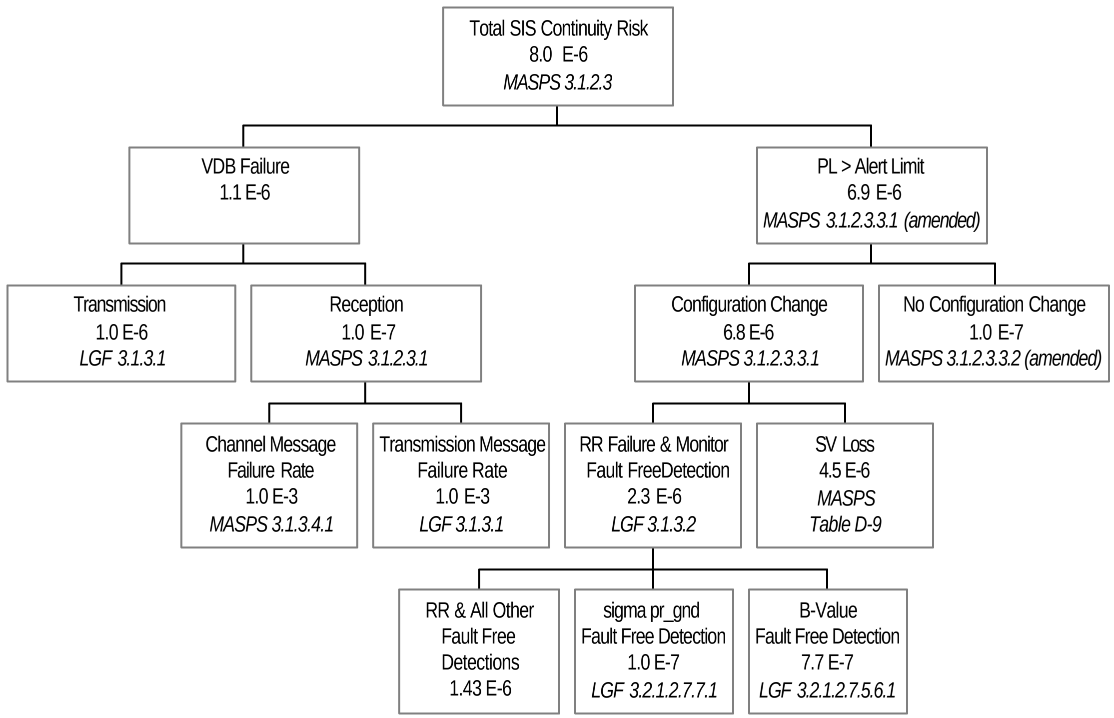
F - 8.3. Ground Continuity Integrity Designator

The Ground Continuity Integrity Designator (GCID) Field is contained in the Type 2 message and indicates the performance level of the approach. This specification addresses Performance Type 1 only, and is indicated in the GCID message field as 001. The LGF requires 111 to be indicated in the GCID message field when the ground station signal does not comply with PT 1 requirements for integrity. It is important to note that while the LGF may be in Test, the LGF can change the GCID according to the actual performance level of the signal. If a fault in the LGF has been corrected, maintenance or flight inspection may prefer to perform additional checks of the system while in Test, and a true indication from the GCID of the actual performance must be provided. If the GCID is broadcasting 001, for PT1, then maintenance will be assured that corrections are included in the broadcast and not have to monitor the VDB messages. Conversely, a GCID of 111 indicates that the system is still unusable and the Number of Measurements Field has been set to zero.

Appendix G
Risk Allocation Trees
Integrity Risk Allocation



Appendix G
Continuity Risk Allocations



Appendix H
Exceptions to the GNSS Based Precision Approach Local Area Augmentation System (LAAS) Signal-in-Space Interface Control Document (ICD)

TYPE ONE MESSAGE*

Data Content	***Bits Used***	***Range of Values***	***Resolution***	***Bytes***
Modified Z-count	14	**0 – 1,199.99**	0.1 sec	-
Integrity Parameter Type **ADDITIONAL MESSAGE FLAG**	2		-	0
Number of Measurements	5	*1 – 31* **0 – 18**	1	-
Measurement Type	3	**0 - 7**	**1**	1
Extended Message Flag	*1*	-	-	-
Spare	*7*	-	-	*1*
Ephemeris CRC	16	-	-	2
Source Availability Duration	8	*0 - 2550* sec **0 – 2540 sec**	10 sec	1
Measurement Block 1				
Ranging Source ID	8	1 - 255	1	1
Issue of Data (IOD)	8	**0 - 255**	-	1
Pseudorange Correction (PRC)	16	±327.67 m	0.01 m	2
Pseudorange Correction Rate (PCR)	16	±32.767 m/s	0.001 m/s	2
σ_{pr_gnd} (unsigned – note 4)	8	0 - 5.08 m	0.02 m	1
B_1	*8*	*±6.35 m*	*0.05 m*	*1*
B_2	*8*	*±6.35 m*	*0.05 m*	*1*
B_3	*8*	*±6.35 m*	*0.05 m*	*1*
B_4	*8*	*±6.35 m*	*0.05 m*	*1*
•				
Measurement Block N				

*Data that are all caps and bolded are message types that are worded differently in the LGF Specification or do not appear in the ICD. Data in italics either do not appear in the LGF Specification or reflect how the ICD is worded.

TYPE TWO MESSAGE*

Data Content	***Bits Used***	***Range of Values***	***Resolution***	***Bytes***
Ground Station Operating Receivers **INSTALLED RECEIVERS**	2	**1 - 4**	-	-
Ground Station Accuracy Designator **ACCURACY DESIGNATOR**	2	-	-	-
Ground Station Health (Spare)	*1*	-	-	-
Ground Station Continuity/Integrity Designator	3	**0 - 7**	**1**	1
Local Magnetic Variation	8	± *32.0°* **± 31.75°**	0.25°	1
Spare	*16*	-	-	*2*
Refractivity Index	8	± 381	3	1
Scale Height	8	± *12,700 m* **0 – 25,500 m**	100 m	1
Refractivity Uncertainty	8	0 - 255	1	1
Latitude	32	± 90.0°	0.0005 arcsec	4
Longitude	32	± 180.0°	0.0005 arcsec	4
Vertical Ellipsoid Offset	24	± 83,886.07 m	0.01 m	3

*Data that are all caps and bolded are message types that are worded differently in the LGF Specification or do not appear in the ICD. Data in italics either do not appear in the LGF Specification or reflect how the ICD is worded.

TYPE FOUR MESSAGE*

Data Content	*Bits Used*	*Range of Values*	*Resolution*	*Bytes*
FAS Approach Performance Designator **DATA SET LENGTH**	**8**	**2 – 212**	**1**	-
FAS DATA BLOCK	**304**	-	-	-
Operation Type	4	**0 - 15**	-	-
Reserved **SBAS PROVIDER ID**	4	**0 - 15**	**1**	1
Airport ID	32	-	-	4
Runway Number	6	0 - 36	1	
Runway Letter	2	-	-	1
Approach Design Information **APPROACH PERFORMANCE DESIGNATOR**	3	**0 - 7**	**1**	-
Route Indicator	5	-	-	1
Reference Path Data Selector	8	*0 – 199* **0 - 48**	-	1
Reference Path Identifier	32	-	-	4
RDP Latitude **LTP/FTP LATITUDE**	32	± 90.0 °	0.0005 arcsec	4
RDP Longitude **LTP/FTP LONGITUDE**	32	± 180.0 °	0.0005 arcsec	4
RDP Height **LTP/FTP HEIGHT**	16	-512.0 - 6041.5 m	0.1 m	2
FPAP Latitude	32	± 90.0 °	0.0005 arcsec	4
FPAP Longitude	32	± 180.0 °	0.0005 arcsec	4
Datum Crossing Height (DCH) **APPROACH THRESHOLD CROSSING HEIGHT (TCH)**	15	*-512.0 - 2764.8 ft* *-200.0 - 1438.4 m* **0 – 3,276.7 ft** **0 – 1,638.35 m**	0.1 ft 0.05 m	-
DCH Units Selector **TCH UNITS SELECTOR**	1	-	-	2
Glidepath Angle (GPA)	16	0 - 90.0 °	0.01°	2
COURSE WIDTH	**8**	**80 – 143.75 m**	**.25 m**	-
DELTA LENGTH OFFSET	**8**	**0 – 2,032 m**	**8 m**	-
Final Approach Segment CRC	32	-	-	4
FAS VAL/APPROACH STATUS	**8**	**0 – 25.4 m**	**0.1 m**	-
FAS LAL/APPROACH STATUS	**8**	**0 – 50.8 m**	**0.2 m**	-

*Data that are all caps and bolded are message types that are worded differently in the LGF Specification or do not appear in the ICD. Data in italics either do not appear in the LGF Specification or reflect how the ICD is worded.

Appendix I
Final Approach Segment – Definitions

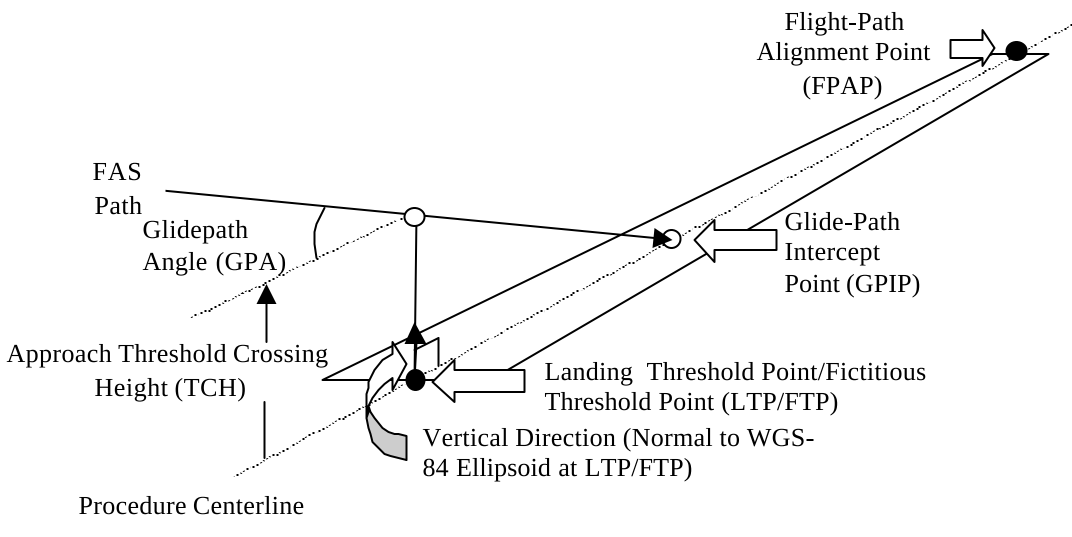


Figure I-1. Final Approach Segment Diagram

I – 1. Final Approach Segment Path Definition

The Final Approach Segment (FAS) path is a line in space defined by the Landing Threshold Point/Fictitious Threshold Point (LTP/FTP), Flight Path Alignment Point (FPAP), Threshold Crossing Height (TCH) and the Glide Path Angle (GPA). The local level plane for the approach is a plane perpendicular to the local vertical passing through the LTP/FTP (i.e., tangent to the ellipsoid at the LTP/FTP). Local vertical for the approach is normal to the WGS 84 ellipsoid at the LTP/FTP. The Glide Path Intercept Point (GPIP) is where the final approach path intercepts the local level plane.

I – 2. LTP/FTP Definition

The Landing Threshold Point/Fictitious Threshold Point (LTP/FTP) is a point over which the FAS path passes at a relative height specified by the threshold crossing height. It is normally located at the intersection of the runway centerline and the threshold.

I – 3. Final Path Alignment Point Definition

The Flight Path Alignment Point (FPAP) is a point at the same height as the LTP/FTP that is used to define the alignment of the approach. The origin of angular deviations in the lateral direction is defined to be 305 meters (1000 ft) beyond the FPAP along the lateral FAS path. For an approach aligned with the runway, the FPAP is at or beyond the stop end of the runway.

Appendix J
Documentation for the LGF

Design oriented documentation:

a. System functional & performance spec with requirements verification matrix traceable to FAA LGF specification

b. ICDs for external interfaces, including LGF, MDT, LSP, RSP and ATCU

c. Test plans and procedures for DT, PAT, SAT, and OT&E and type acceptance for non-federal certification.

Installation and maintenance oriented documentation:

a. Installation drawings (including information necessary to physically site and operate an LGF (including RSP & ATCU) installation) in accordance with FAA-STD-002.

b. Technical Instruction Books (TIB) in the same order and containing the same information as FAA TIBs and in accordance with Technical Instruction Book Manuscripts: Electronic Equipment Requirements for Part - Preparation of Manuscript, FAA-D-2494B.

c. Training Plans